CHEMISTRY

25¢

Pulling Atomic Teeth

➤ INSTEAD OF rejoicing in the first application of atomic power to peaceful living, we are now, three years after harnessing atomic energy, worrying about nasty smears upon scientists' reputations. These are endangering our atomic energy program and therefore our national security.

President Truman in his address to the American Association for the Advancement of Science said:

"Continuous research by our best scientists is the key to American scientific leadership and true national security. This indispensable work may be made impossible by the creation of an atmosphere in which no man feels safe against the public airing of unfounded rumors, gossip and vilification. Such an atmosphere is un-American. It is the climate of a totalitarian country in which scientists are expected to change their theories to match the changes in the police state's propaganda line."

Chairman David E. Lilienthal of the U.S. Atomic Energy Commission said:

"Government service has now taken on an extra, an added unattractiveness, an added disability: the risk of undeserved injury to a man's good name, his professional standing and his peace of mind through anonymous vilification, through attacks from what may be petty or prejudiced or malevolent sources. Piled on top of all the other familiar disabilities of public employment, this often makes work for the Government appear as something to be shunned. Public employment has become, in a very real sense, a hazardous occupation. The increasing unwillingness of specially qualified (and badly needed) scientists, engineers and management experts to engage in work for the Government of the United States . . . imperils some of the broadest, deepest and most immediate interests of the people of our country."

The Federation of American Scientists said:

"After the House Un-American Activities Committee's attack last March on Dr. Edward U. Condon, director of the National Bureau of Standards, a poll was taken of a group of the scientists who helped to develop the atomic bomb. It showed that 75% have either decided to decline government employment or have been made reluctant to accept government employment as a result of this action."

Our atomic teeth are being drawn by politicians within our nation's borders.

CHEMISTRY

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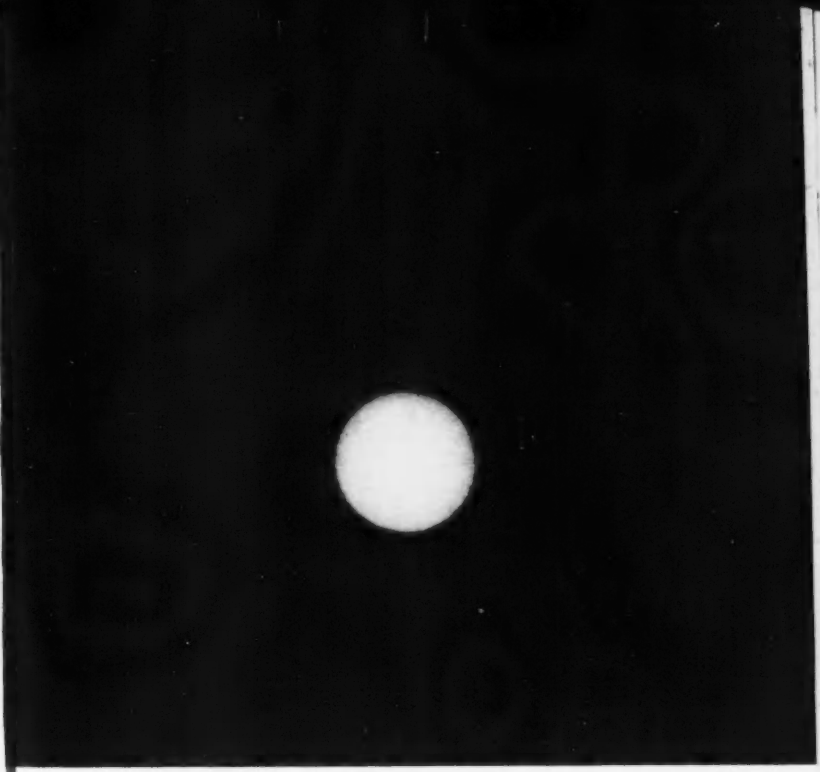


➤ SODIUM CHLORIDE *shows a symmetrical pattern by neutron beam photography. The hole in the center results from the way the beam is used. Ten hours of exposure were required to obtain the picture.*

As The Neutron Sees It

by HELEN M. DAVIS

➤ NEUTRONS, which stream from the chain reactor at Oak Ridge, give opportunity for experimenters to show what can be done with them. One trick that has suggested itself to scientists is the use of this stream of vibrating neutral particles as though it were a beam of light.

Since neutrons are neutral particles, they are able to penetrate very close to the hearts of atoms. If they could be made to register on a photographic film, they could reveal what they found there.

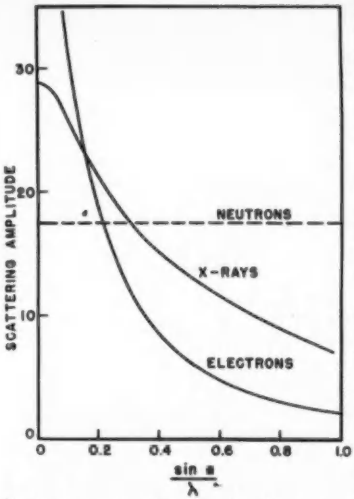
In a recent article in the journal *Science*, Drs. C. G. Shull and E. O. Wollan of the Oak Ridge National

Laboratory tell how they induced neutrons to simulate a light beam, and what they learned through these experiments. Crystals whose atom structure does not register well when photographed with X-rays or with electron beams showed the arrangement of their atoms much better in a number of instances when the neutron beam was used.

The contrasts between photographs taken by the three kinds of beams give a clearer understanding, for example, of compounds containing hydrogen. The light element shows up better with neutrons than with the other methods. New information has also been obtained on the puzzle of alloy structure.

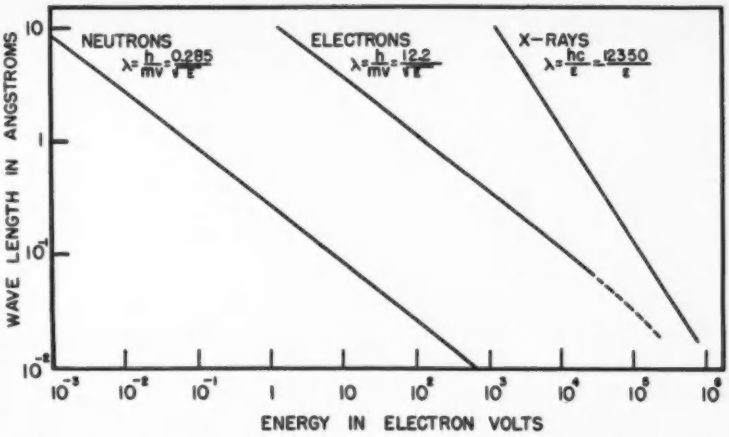
"Although the radiations or particles with which we are here concerned," say these authors, "namely, photons, electrons, and neutrons, have widely different physical characteristics, they have the one property in common that there is associated with each a wave length which depends on the energy of the particular particle. The wave lengths which are useful in the study of crystal and molecular structure must be of the order of the distance between atoms in crystals or molecules in order that noticeable diffraction effects will be observed. Since atomic spacings are of the order of an angstrom, the useful wave length range will lie in the region from about 0.1 A to 10 A. With the proper choice of energy, X-rays, electrons, and neutrons can all be obtained with wave lengths lying in this region. The cut shows the relation between the energy and the wave length for these three radiations."

The technique of photographing



➤ AMPLITUDE *of scattering by copper atoms for various radiations.*

crystal structure by light beamed through the crystal was pioneered by Max von Laue before World War I, in researches which won him the Nobel prize in 1914 and, this year, an honorary degree from the University of Chicago. He used X-rays, whose wave length is of the right size to be diffracted by the rows of atoms which build the crystal planes. The picture imprinted on the photographic plate by the X-rays after such diffraction shows a symmetrical pattern of light and dark areas. By projecting back the paths that the beams of short-wave light must have followed to produce this pattern of alternate clear and obstructed areas, chemists have learned that the distinctive patterns of crystal shape extend right down to the arrangement of the atoms that build them. Moreover, the actual



➤ COMPARISON *of the relationship between particle wave length and energy for X-rays, electrons and neutrons.*

locations of the atoms can be identified, and the angles between the rows and planes formed by these atoms can be measured. Thus chemists can speak very glibly about angles and distances in structures far below the limit of visibility.

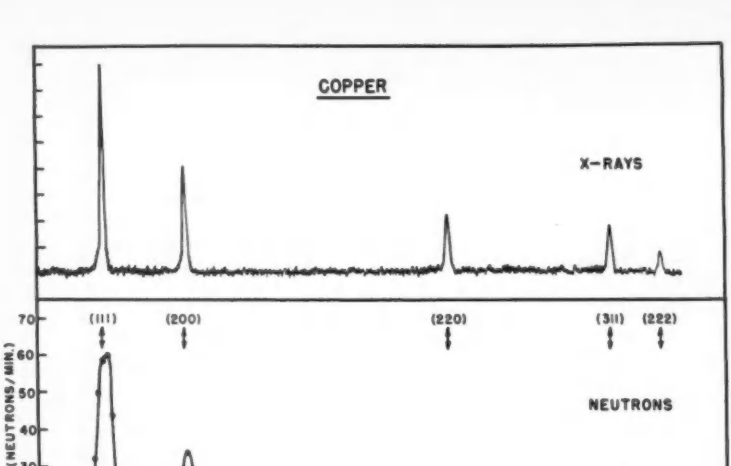
Once its structure has been mapped, the crystal itself can in turn become a measuring device. A beam of electrons can then be shot through a crystal whose pattern is known from X-ray study, and the difference between the patterns registered on the photographic plate by the two types of beams can be observed.

The principle of a pinhole is used to get a beam for this purpose. A tiny aperture in a thick shield, usually a lead plate, lets a small stream of X-rays or of electrons pass through like a pencil of light into a darkened room.

In the same way, Dr. Shull and Dr. Wollan used a beam of neutrons emanating through a hole in the concrete shielding around the Oak Ridge pile. The hole, which in this case was $\frac{1}{4}$ inch in diameter, was better defined by a piece of plastic containing boron which is a strong absorber of neutrons. The resulting beam has somewhat the effect of a jet, with all the neutron particles rushing in the same direction.

The neutron beam adds to X-rays and electrons a third kind of probe into the structure of crystals. Each probe gives a different sort of information. But with the neutron beam several new problems present themselves. Neutrons are not energy units, they are matter. They are some 1800 times as heavy as electrons. They act like a gas. Nevertheless, because their ultimate particles are still very small, they also behave like waves.

Neutrons as they are first liberated have very high velocity, therefore



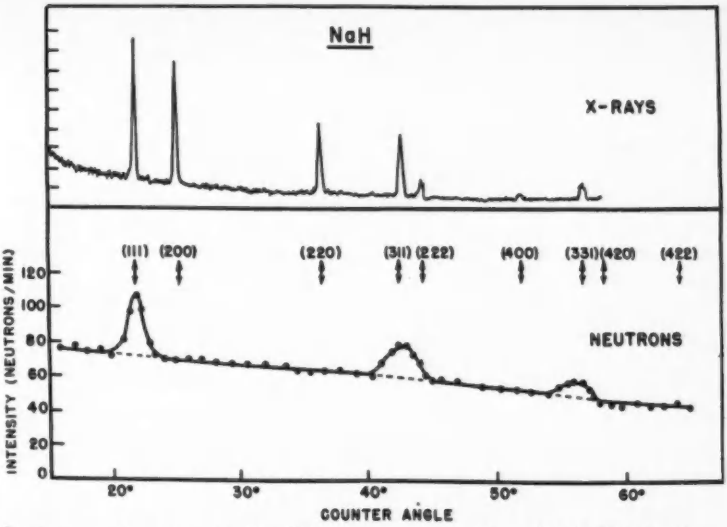
▶ X-RAY *and neutron powder diffraction patterns taken with copper powder.*

their wave length is very short. Only by letting them cool down to a low velocity can their wave length be stretched out to the dimensions of crystal spaces. This done, the neutron beam can be shot through the crystal so that the planes will diffract the beam and create a pattern corresponding to the thick and thin areas in the X-ray and electron beam photographs.

But while the other beams register their patterns on photographic film, the emerging neutron beam can be neither seen nor photographed.

The scientist, at this point, far from being discouraged, finds the solution of this problem easy. It is implicit in the problem of detecting neutrons, which has already been solved. Certain elements, when they absorb neutrons, give off beta rays or electrons, which are forms of energy that will imprint themselves on light-sensitive emulsion. The unusual metal, indium, is the scientist's choice for the purpose. He lays a piece of indium foil over a piece of X-ray film, allows the neutron beam that has passed through the crystal to fall upon it, and the electrons released enable the neutron beam to tell of its course among the crystal atoms.

Since the distances measured by the three kinds of beams are so minute, it is not necessary to use a single crystal, big enough to handle and scarce as a rare gem, to make these measurements. All crystals of



▶ X-RAY *and neutron powder diffraction patterns taken with NaH. The X-ray pattern is characteristic only of Na scattering and the difference between the two patterns shows the influence of neutron scattering by hydrogen.*

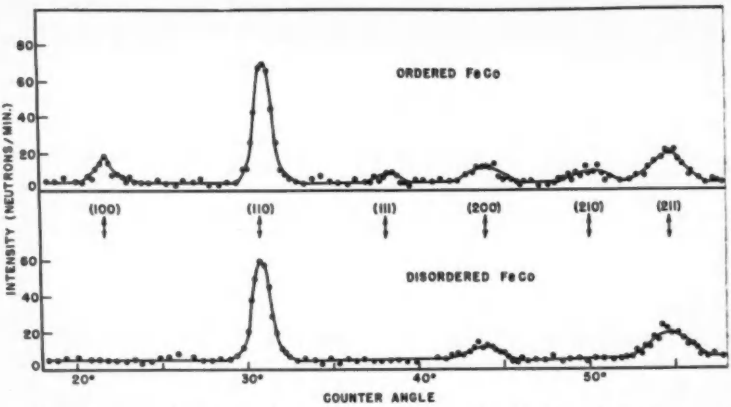
the same substance are built on the same specifications and their fundamental measurements are interchangeable. A modification of technique makes it possible to substitute for the single crystal a fine crystalline powder of the same material. Each tiny crystal in the powder is still enormous compared to the unit size of the atoms being examined and the wave length that makes them visible.

After making the crystal structure visible by the three different methods, the scientists are eager to compare photographs. Drs. Shull and Wollan, in their article, state that the nature of the interaction of X-rays, electrons, and neutrons with individual atoms and nuclei is found to be very different for the three types of radiations.

"The scattering of X-rays by atoms," they say, "takes place almost entirely from the electronic cloud surrounding the atomic nucleus, there being negligible scattering by the nucleus itself."

A measure of the effects of this scattering is graphed in the accompanying diagram. Here the fact is brought out that for neutrons the results are quite different from those due to the older techniques.

"In structure determinations," the authors continue, "the absolute scattering cross sections are not important as long as there is sufficient scattering by the sample. The relative scattering by the different atoms or nuclei in a crystal or molecule will be the determining factor in structure analysis.



➤ NEUTRON *powder diffraction patterns taken with samples of ordered and disordered preparations of FeCo alloys.*

With X-rays and electrons the scattering by a hydrogen atom which has only a single electron will be very weak compared to the scattering by atoms of larger atomic number, since the amplitude increases about linearly with atomic number. With neutrons there is no regular variation of the scattering amplitudes from one element to the next, and hydrogen and deuterium have scattering cross sections comparable to other elements; hence, structure determinations involving these nuclei may be much more feasible with neutrons than with X-rays and electrons."

With the older techniques it was impossible to locate hydrogen atoms. Neutrons show up hydrogen along with all the other elements. Thus at once there is opened a new field of investigation into the structure of several kinds of chemicals. These include myriads of organic chemicals. They include also the controversial hydrides. Dr. Wollan and his associates at Oak Ridge have already learned that sodium hydride has a crystal form quite similar to that of sodium chloride, with atoms of the two elements alternating with each other at the corners of cubes.

Recently, too, this research group has reported success in photographing, with their neutron technique, the position of hydrogen atoms in ice. With the aid of deuterium atoms, they have learned that hydrogen is not frozen in one position, but jumps about from one place to another in the ice crystal.

Another chemical puzzle on which the new technique can furnish decisive data concerns the structure of alloys. Many scientists have held the view that these combinations of metals do not have structure in the sense that chemical compounds do. Others have thought that inter-metallic compounds can be formed. Neu-

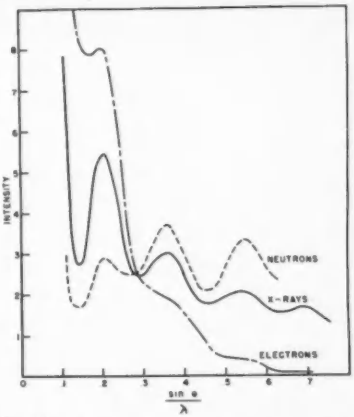
tron beam photography may help to resolve this controversy.

With some alloys the difficulty with X-ray photographic analysis is not that the atoms are invisible but that they look so much alike, in the case of iron-cobalt alloys, for example, and that the effects of the two metals overlap and create confusion. The researcher could not be sure of the meaning of his pictures. With the neutron beam this confusion can sometimes be eliminated. Effects created by the two metals can be distinguished. Differences can be made out between ordered patterns in alloys formed under certain conditions and disordered arrays of atoms in alloys formed at other temperatures and pressures.

Many chemicals whose structure is not determined to the satisfaction of those who study them await the application of this new direct method of spotting their atoms. The Oak Ridge team warns that determination of complicated structures takes a great deal of time, and that their facilities are limited.

Among problems awaiting the results of neutron beam photography are those of matching X-ray and electron beam photographs of gases and liquids. New understanding of the way atoms combine, whether by molecular groups or singly, will correct or verify the way chemists write their formulas.

In the realm of the infinitely small, which we are completely unable to see, we are coming to know by direct evidence how the minute units of matter build the universe we perceive.



➤ THEORETICAL *scattering curves for CCl_4 vapor for X-rays, electrons and neutrons. The former two curves have been verified experimentally while the latter curve (neutron) has been calculated using the known neutron scattering amplitudes for carbon and chlorine.*

On the Back Cover

➤ "GREAT *beauty and clarity" is one scientist's description of the crystal patterns revealed by neutron beam photography. This pattern appeared when a quartz crystal was used. Neutron beam photographs and diagrams are from Dr. Wollan and his associates at Oak Ridge National Laboratory.*

Not Poisonous to Man or Animals, New Chemical Fights Flies, Beetles and Other Insects

Methoxychlor To Rival DDT

➤ MAN'S chemical warfare against the insects has been reinforced by a cousin to DDT that doesn't poison man and animals and slays bugs untouched by other insecticides.

It is called methoxychlor. A du Pont chemist, Dr. C. J. Krister, has given the first full report on this chemical that has now had extensive trials in actual use.

Predicting that it may find a place more important than DDT, Dr. Krister told the American Chemical Society meeting that methoxychlor is so safe that it can be swallowed by human beings and animals with little danger. Rats fed it in moderate doses over months suffered no adverse effects.

One of the major troubles with DDT has been the danger to animals, particularly cats and other pets, and the low toxicity of methoxychlor is allowing its safe use on controlling lice, flies and other insects that worry cows, pets and man.

The Mexican bean beetle, not adequately controlled by DDT and other similar compounds, is effectively killed by the new insecticide.

Beans, cucumbers, peaches, apples, grapes and other crops that might carry dangerous insecticides to the dinner table may be treated with methoxychlor without danger.

Cows because fly-free will give more milk without risk of getting chemical contamination of their milk when sprayed with methoxychlor. It is not picked up and absorbed through the skin and accumulated in the fat of beef cattle.

Flies are knocked down immediately by the new chemical, thus eliminating the need for imported pyrethrum which has to be used with DDT to put the insects out of commission promptly. Methoxychlor may become the chemical-of-choice in fly fighting.

Methoxychlor is the approved short name for the chemical whose full name is bis(p-methoxphenyl)trichloroethane. Another DuPont chemist, E. W. Bousquet synthesized it in 1943 during a methodical search for a compound that was both effective in fighting insects yet safe for use around warm-blooded animals.

So far it has been available in limited quantities commercially under the trade name of Marlate as a wettable powder that can be worked up into a water spray. It costs somewhat more to produce than DDT but is not expected to be markedly more expensive to apply.

"For use as an insecticide in the agricultural and household fields, methoxychlor can be readily formulated as dilute dusts, wettable powders, liquid oil concentrates, oil emulsified concentrates and aerosols," Dr. Krister stated. "It is insoluble in water, acids, and alkalies. Methoxychlor is remarkably resistant to oxidation, and upon indoor exposure it will remain unchanged almost indefinitely."

Growth Regulators Push Farms Farther North, Kill Weeds, Bring Seedless Fruits, Speed Harvests

Chemicals Fight World Starvation

➤ CHEMICALS now being investigated hold the possibility of increasing the food production of the world so that a "population suicide" of civilization can be averted.

The same kind of growth-regulating chemicals that make lawns and fields weedless (2,4-D is the common one) can be developed to:

Produce crops of higher yields per acre.

Bring speedier maturity to a crop, either to foil a late season or to grow the plants farther north.

Eliminate the necessity of crop rotation to combat weeds.

Yield seedless, larger and more delicious fruits.

A report was presented to the American Chemical Society meeting by two Army chemical corps chemists, R. L. Weintraub and A. G. Norman, from Camp Detrick, Md., known for biological warfare research. It gives a glowing forecast of the increased usefulness of plant growth regulators.

Some of these chemicals would have been used to wipe out enemy crops if the war had continued longer.

While the chemical plant regulators have been applied mostly to flowers and fruits, the government chemists predict that they can be made to have profound effects upon the major food and fiber crops of the world. Field crops as well as specialized crops might be so influenced chemically that they can be grown in climates and upon soils where they cannot now be harvested profitably.

Plants might be modified by chemical treatment to give more resistance to insects and plant diseases.

Earlier flowering and maturity of plants, possible by chemical treatment, would make many crops possible for northern latitudes where the growing season is short.

A diversity of chemical compounds possess growth regulatory activity, the chemists reported. There appears to exist a close correlation between activity and molecular structure. Information as to the mechanism of action is as yet scanty.

Seedless fruit of exceptional size and flavor has been produced without pollination by chemical treatment of fruit-tree blossoms. Sweeter tomatoes and wheat richer in protein have resulted from the use of growth-regulators. The ripening of bananas in storage has been accelerated, the flowering time of pineapples has been controlled to meet seasonal requirements, and premature fruit fall has been averted, all by chemical means.

The common field crops that bulk large in producing the food and fiber of the world may be as susceptible to controls as are those horticultural and fruit crops that have received more attention.

Poor pasture lands may be treated

to provide perpetual forage for the raising of meat animals. Much higher yields of corn and other staple grains probably can be assured.

A revolution in agricultural practice has been launched by the development of the potent new weed-killer, 2,4-D, and even better herbicides which are already on the way. Crop rotation and many other farming operations used primarily for the purpose of weed control may be virtually eliminated, while the reduction of weed competition in itself assures a tremendous rise in the world's food supply.

The potential value of growth-regulating compounds, however, goes far beyond the indirect use of 2,4-D to destroy weeds. As knowledge of these chemicals expands their greatest importance will be found in their power to govern the growth and quality of crops through direct application.

It should be possible ultimately to create "tailor-made" hormones to produce specific properties in plants.

One of the primary goals of scientific agriculture has long been to provide for every locality plants fully adapted to that environment and therefore capable of making maximum yields under the prevailing climatic and soil conditions. It is now highly probable that some of the factors governing plant adaptation will be susceptible to control or circumvention by growth-regulators.

This may result in higher yields, or a greater certainty of yield. Furthermore, it may also result in some change in crop distribution. Flowering time, flower abundance, fruit and seed setting, and maturity date may be susceptible of control.

In a late season, flowering of some plants might be advanced in order to secure maturity before the frosts of autumn. In an early spring, bud development and flower opening in fruit crops might be delayed to obviate late frost injury. Parthenocarpic fruit setting may be widely practiced with the result that seedless or almost seedless fruits and vegetables become common. The dependence upon insects and other natural pollinating agencies may be reduced and so provide greater latitude in the use of insecticides.

Visible changes in the structure or yield of fruit or grain, or the edible part of any crop, may be accompanied by changes in chemical composition.

This aspect has received little study as yet. The indications are, however, that the balance between reserve carbohydrates and simple sugars may frequently be changed as the ripening process is delayed or accelerated by growth-regulators.

The combination of crop control and composition control might be of outstanding importance with certain grasses and forage crops. The digestibility, palatability, and feeding value of pastures decline rapidly as the dominant grasses head and mature. Delayed heading, or inhibited heading, with a resultant permanently vegetative leafy plant, might greatly change the quality of pastures and permit more intensive use of grazing land and meadows in the humid regions.

Plant-growth regulators, which have been discovered within the past few

years, differ both from fertilizers and from insecticides and fungicides. Unlike fertilizers, which supply major or minor nutrient elements, the growth regulators are not required for growth but can control the development of a part or parts of the plant, the paper explained. Unlike insecticides and fungicides, which afford protection from external injury, the regulators act directly upon the plant.

Even though 2,4-D, the best known member of the new class, is used chiefly as a weed-killer, the compounds should not be classified as herbicides, and even as herbicides they have little in common with the contact herbicide of the past.

Although regulators are frequently referred to as plant hormones or phytohormones, there is real doubt as to whether their mode of action is in any way analogous to that of the hormones produced in the animal body. Animal hormones are highly specific in character and, in general, control a limited set of transformations, whereas the so-called plant hormones often appear to be relatively unspecific and to control, initiate, or direct several apparently unconnected changes.

The uses to which regulators have been put so far fall in general into two categories. One involves some inductive or formative effect on the plant. The other has a primarily inhibitory or even lethal effect. It is likely that many applications of both types remain to be developed.

Vegetative propagation of plants has been aided greatly by the discovery that root initiation can be induced in cuttings of many species by brief treatment with growth-regulating compounds, the most widely used being indole-3-butyric acid and alpha-naphthaleneacetic acid.

By treatment of some flowers with certain growth-regulators, fruit set without pollination may be accomplished. The fruit so obtained is seedless. Applications are usually made by aerosol or vapor treatment. Fruit so produced may be larger in size or weight than fruit formed as a result of normal pollination, although undesirable changes in the morphology of the fruits may be encountered if the optimum treatment rates are exceeded.

Chemical treatment may also prevent flower drop and insure fruit development from flowers which have been previously pollinated. This technique has been employed widely by growers raising tomatoes in green houses where pollination normally is poor, and it appears possible in this way to overcome also the adverse effects of low night temperatures on fruit setting of early field-grown tomatoes.

Certain compounds are capable of inducing development of flower buds and so afford some control of the time of flowering. This has proved successful in pineapple culture. Alpha-naphthaleneacetic acid has been the compound mainly employed. Curiously enough, this same compound, as well as derivatives, is highly effective in inhibiting bud development in many other plants and is widely employed for preventing sprouting of potato tubers in storage.

On the other hand, chemicals are known which have a bud-stimulating influence, and these are used for inducing sprouting of dormant buds,

for example in potatoes which are to be planted as seed.

Efforts to delay the flowering of fruit trees, such as peach and apple, to reduce frost danger in the spring, have not been entirely successful, but chemicals have been employed to prevent pre-harvest dropping of fruits. Apparently the chemicals delay the development and separation of the abscission layer of cells which is responsible for fruit fall, without causing any appreciable change in the rate of ripening. Exposure to a low concentration of 2,4-D has been found to accelerate the ripening of bananas in storage.

Up to now, the applications of growth-regulators in the herbicide field surpass all other uses in importance to agriculture and to the chemical industry. Although the compounds, led by 2,4-D (2-4-dichlorophenoxyacetic acid), are not inherently selective in activity, they can be utilized in a selective manner by taking advantage of differences in sensitivity and response among species.

Most important, it has been found possible to control weed growth in a planted or growing crop, either by spray treatments which inhibit weed growth selectivity, or by soil treatments which prevent germination and development of weed seedlings.

The present preoccupation with 2-4-D is scarcely likely to be maintained. Although 2,4-D is a broadly effective and highly inhibitory compound, others that may be safer to use or better suited for particular purposes are already known and it seems safe to predict that still others remain to be discovered.

Developments in weed control may result in far-reaching changes in cultural practices. Some rotations and many agricultural operations have been adopted primarily for purposes of weed control. A greater measure of chemical control of weed competition in the growing crop would surely allow more intensive cropping and, hence, require greater attention to be given to the nutrient status of the soil. The per acre yield of corn can probably be appreciably increased if the old 42-inch check row spacing is abandoned.

Research in the general fields of weed control and crop control is now being conducted largely in an empirical manner, with interest centered in 2,4-D and naphthaleneacetic acid or their derivatives. A major obstacle to the development of new growth-regulators and additional uses for such compounds is the lack of fundamental knowledge of their mechanism of action.

The horizons are not yet clearly discernible. The potentialities and limitations cannot, therefore, be sharply outlined, but it is certain that agricultural practices may be greatly changed in form and direction by the availability of these new chemical tools.

Considering only the chemical constitution, a soap is any salt of those fatty acids that contain eight or more carbon atoms.

A sulfate plant is in operation at Osijek, Yugoslavia, to produce fertilizer, and also copper sulfate needed by grape growers.

Only Few Parts in Billion Needed To Trace Use of Element in Plants

Radiophosphorus Tags Fertilizer

► ASTONISHINGLY minute quantities of radioactive material are required for tracer studies of plant nutrition.

Radioactive phosphorus need be present only in the amount of 1.5 to 3 parts per billion of total phosphorus to make possible experiments lasting throughout a growing season of five to six months, W. L. Hill, E. J. Fox, and J. F. Mullins of the U. S. Department of Agriculture, Bureau of Plant Industry, Soils, and Agricultural Engineering at Beltsville, Md., told the American Chemical Society's fertilizer division.

Radioactive phosphorus is used as a tracer to determine the utilization of applied phosphate by growing plants. It makes possible a comparison of the efficiencies of different phosphates — superphosphate, dicalcium phosphate and the like — on fertile as well as infertile soils. Heretofore, the determination of the efficiency of a fertilizer could be made only on an infertile soil—one that would show growth response to the applied fertilizer. Yet the bulk of commercial fertilizers is actually applied to relatively fertile soils.

Radioactive phosphate behaves in the same way as ordinary inactive phosphate, except for its radioactivity that permits detection of extremely minute amounts of it. When a small amount of radioactive phosphate is intimately mixed into a phosphate fertilizer, superphosphate, for example, and the fertilizer is applied to a soil, the vegetation grown thereon becomes radioactive to a degree that depends on the amount of applied phosphate taken up from the soil. Measurement of the intensity of radioactivity in the vegetation and determination of the phosphate content by chemical analysis supply the essential crop data for calculating the proportion of the phosphate in the vegetation that came from the superphosphate.

A greenhouse experiment of the tracer type, requiring beaker-size lots of materials, was conducted by the Bureau in late 1946. Less than a year later plans were nearly completed for elaborate field experiments comprising five radioactive phosphate fertilizers and eleven crops in five states. The fertilizer requirement of 700 to 800 pounds of radioactive phosphates necessitated the provision of special equipment in an isolated room for their preparation.

Because the necessary radioactivity is a menace to health, special precautions are followed from the beginning to the end of the experiment. The preparation of superphosphate, ammoniated superphosphate, dicalcium phosphate, alpha tricalcium phosphate (principal crystalline phosphate in defluorinated phosphate rock) and calcium metaphosphate glass was accomplished with proper precautions because of the health hazard.

A very active phosphate was diluted with inactive phosphate and the mix-

ture was converted into desired form. The active phosphate was potassium acid phosphate that had been irradiated in the pile at Oak Ridge, Tennessee. Upon removal from the pile both phosphorus and potassium are active, but because the life of radioactive potassium is very short, its activity soon disappears, so that the residual activity is due to phosphorus alone.

This radioactive phosphate, of which only a small part of the phosphorus is radioactive, was diluted 55- to 110-fold with ordinary phosphate. As a consequence, the radioactive phosphorus content of the fertilizer was only 1.5 to 3 parts per billion parts of total phosphorus. Surprisingly enough, the radio-activity originating from this small amount of active material is more than adequate to carry an experiment through a growing season of five to six months.

The chemical behavior of radiophosphorus is identical with that of ordinary phosphorus. Use was made of conventional methods for processing phosphates with suitable modifications in technique to provide practically complete recovery of material and protect the people working with the material.

Crops Need Micronutrients

➤ WIDESPREAD crop failures are a danger in the future unless American farmers feed their plants manganese, copper, boron and zinc as well as the conventional nitrogen, phosphorus and potassium fertilizers.

America's high crop yields are removing from the soil plant nutrients needed in small but essential quantity, George H. Serviss, Ithaca, N. Y. chemist, told the American Chemical Society.

While farmers are fertilizing their fields more heavily with relatively pure salts of the three basic fertilizers, nitrogen, phosphoric acid and potassium, they are not replacing in most cases the chemical elements needed in smaller amount that large crops remove from the land.

Adding the secondary or micronutrients to the standard fertilizer mixtures according to how they are needed in various parts of the country was advocated by Mr. Serviss.

High crop yields remove more natural plant foods from the soil than do low yields, Mr. Serviss explained.

Soil chemists, agronomists, and horticulturists today generally agree that we have a secondary and micronutrient problem in the fertilization of crops, but they do not agree on how widespread it is, or on how best to handle it. Most probably agree that the problem will be more widespread in the future than it is today.

Farming is becoming more intensive. Farmers who once thought 200 bushels of potatoes to the acre a good yield are now disappointed at less than 400. High yields naturally remove more of the various plant foods from the soil than low yields.

American Chemical Society Hears New Research, But Much Testing Needed Before Human Use

Medical Angles to Chemistry

When the American Chemical Society meets there are always many reports of promising developments in the field of medicine. In some cases even the most promising researches in the laboratory do not fulfill their expectations in the clinic. Some of these are therefore hopeful progress reports so far as curing human disease is concerned.

More Potent Than Cocaine

➤ DISCOVERY of a new pain-killing drug many times more potent than cocaine was reported to the American Chemical Society by four chemists who collaborated in research on the compound at the Smith, Kline & French Laboratories in Philadelphia.

The new drug, the best of numerous chemicals tested during a five-year study of local anesthetics, cannot be made generally available until elaborate clinical tests have been completed, explained a report presented by James W. Wilson and Glenn E. Ullyot of Smith, Kline and French; Norman D. Dawson of Washington Missionary College, and Walter Brooks of the University of Pennsylvania.

Technically, the drug is known as 1-(B-dimethylaminoethoxy)-4-butyl-isoquinoline, but for the sake of brevity it has been designated as SKF 538-a. It is one of a promising series of nine local anesthetics recently synthesized by a new method. Eight of the nine compounds were found to produce significant local anesthetic activity when tested on the cornea of a rabbit's eye.

While SKF 538-a is still definitely in the experimental stage, pharmacological studies show it to have a pain-killing effect lasting much longer than cocaine, procaine, or dibucaine. These studies have been made under the direction of Dr. E. J. Fellows, associate professor of pharmacology of Temple University Medical School.

Dr. Fellows found the drug was so strong that a dilution as low as 0.01 per cent produced anesthesia in rabbits which lasted for over three hours. A similar solution of dibucaine produces anesthesia lasting 69 minutes, while 1 per cent solutions of cocaine and procaine produce anesthesia lasting only 18 and 2 minutes, respectively.

Better Streptomycin

➤ CHEMISTS are attempting to develop a form of streptomycin to which germs will not become resistant.

How derivatives of the drug can be prepared which will eliminate its principal therapeutic defect and thus greatly extend its usefulness was described by Dr. Walter A. Winsten of the Food Research Laboratories, Long Island City, N. Y. to the American Chemical Society.

In the treatment of bacterial infections with streptomycin, the bac-

teria often become resistant to the drug, making its further use of little value, Dr. Winsten said. One of the reasons is that the streptomycin does not reach all sites of an infection in the animal body in sufficient concentrations. As a consequence, bacteria present at such sites are exposed to sub-lethal amounts of the drug and thus become acclimated to it.

Derivatives of streptomycin of modified solubility characteristics might have, as a consequence, an altered distribution in the animal body. Dr. Winsten studied the possibility of obtaining derivatives of streptomycin of modified solubility, still active as antibiotics.

Test tube studies indicate that various derivatives of the antibiotic can be prepared which are more soluble in an organic solvent than the parent antibiotic. Whether any of the derivatives prepared will have therapeutic value by virtue of their changed solubility characteristics is still to be determined by animal tests.

Fungus-Fighting Chemical

➤ DEVELOPMENT of a potent new chemical which kills the fungi responsible for athlete's foot, ringworm of the scalp, and plant losses estimated at more than two billion dollars a year was announced to the American Chemical Society.

The synthetic product, called Echridine, is so powerful that in laboratory tests it has proved effective against fungi even when diluted to a strength of one part in 150,000, according to a report presented by Dr. F. E. Cislak, director of research of the Reilly Tar and Chemical Corporation, Indianapolis, Ind. Proof of its therapeutic value must await the outcome of clinical tests.

Fungi are microscopic plants which require warmth, oxygen, water, and food to live. For food they like carbohydrates, proteins, and fats. Several hundred thousand types of fungi exist in nature, some of which, such as the parasitic fungi, attack living tissues, while others, called saprophytic fungi, attack dead matter.

Loss of food crops through fungus disease represents a substantial part of the huge total damage caused by fungi each year, according to Dr. Cislak, who added:

"The loss of lumber through decay, also caused by fungi, is of serious proportions. The mildew staining of fabrics, the molding of leather, the rotting of tents, tarpaulins, and ropes, are all the result of fungus infections.

"More serious than the dollars and cents loss caused by fungi are the fungus diseases which afflict human beings. An example of the fungi pathogenic to human beings is the common athlete's foot fungi. In the hot, humid climate of the Pacific islands our fighting forces encountered fungus diseases that were most serious. Recently, the control of ringworm of the scalp has become a problem of major importance."

Echridine is a derivative of pyridine known technically as 4-(4-ethylcyclohexylmethyl) pyridine. Previous attempts to prepare fungicides from pyridine had resulted in failure, and it had been assumed that the compound had only mild, fungicidal properties. The Reilly researchers disregarded the earliest data, and screened

hundreds of chemicals. They found that they could produce a strong fungicide by certain changes in the pyridine molecule. Knowing the necessary molecular composition, they were able to synthesize Echridine.

Pyridine compounds are recovered from the coke oven gases of steel mills. Less than a decade ago, these pyridines were burned, because there was no known use for them. Then, a way was found to employ pyridine in waterproofing cloth.

Next, it was discovered to be one of the vital bases in the Vitamin B complex. During the war, pyridines were used in the manufacture of synthetic rubbers. More recently, it has been found that pyridine compounds can be used to alleviate the symptoms of allergies, such as hay fever.

Drugs for High Blood Pressure

➤ TEMPORARY relief from high blood pressure is afforded by a series of new drugs, the most potent of their kind, described before the American Chemical Society.

If the new drugs prove satisfactory for human therapy, they may be valuable for periodic treatment of hypertension or for reduction of dangerously elevated blood pressure in preparation for surgical operations, according to a report by Dr. Richard Baltzly and Dr. Edwin J. de Beer of the Wellcome Laboratories, Tuckahoe, N. Y.; Dr. Johannes S. Buck of the Sterling-Winthrop Research Institute, Renssalaer, N. Y., and Dr. Frederick J. Webb of the Firestone Tire and Rubber Company, Akron, Ohio.

To date, the compounds have been administered only to dogs, but clinical tests now getting under way will determine whether they are safe and effective for treating human beings.

Given by injection in minute doses to anesthetize animals, the new drugs produce precipitous drops in blood pressure, a significant effect lasting for as long as two hours. The action of most other drugs of this type is so short-lived as to make them almost totally useless for therapeutic purposes.

Discovery of the drugs, which are known as depressors, was purely accidental, occurring during routine physiological tests of other synthetic chemicals which were under investigation.

A series of N-methyl tetrahydroisoquinolines had been prepared, most of the members of the series being obtained pure without much difficulty. In the case of one, however, namely 6-ethyoxy-N-methyl tetrahydroisoquinoline, the properties of the substance were rather unfavorable for purification, and the sample obtained was not actually pure but was contaminated by side products having similar physical properties and similar composition so that analysis did not reveal their presence.

The rest of the N-methyl tetrahydroisoquinoline family proved uninteresting from a physiologist's viewpoint, but the 6-ethoxy member showed amazing depressor activity. Further study showed that this effect was due to impurities, present in small quantity and therefore of unusual potency, it was said.

These impurities have now been prepared in concentrated form and have been found to consist of two

kinds of molecules, those of phenethylamines and formaldehyde, which are linked alternately in short chains according to the report.

By altering the synthetic process, preparations ten to one hundred times as active as the original preparation have been obtained, it was reported, and these have been administered intravenously to anesthetized dogs.

Doses of two-tenths to four-tenths of a milligram per kilogram of body weight, of the drugs (a million milligrams being equal to one kilogram) produce profound drops in blood pressure.

The fall in pressure is precipitous and is followed first by a moderately rapid and then by a slower rise, they said, the time required for restoration of the initial blood pressure being usually one to two hours. In smaller doses, even as low as two-hundredths of a milligram per kilogram of body weight, a significant fall may be observed, lasting for twenty to thirty minutes, but the effect of such minimal doses is complicated by individual variation in the animals.

Potential utility in the human species is fairly obvious, but only clinical trial will determine if this utility will be realized.

Painless Spray Injections

➤ THE PAINFUL jab of the hypodermic needle will soon become obsolete. Commercial introduction sometime next year of a jet method of spraying medicines into the body by a very fine stream under high pressure, was promised in a report to the American Chemical Society.

Thousands of injections by the new needleless "hypospray" method have shown it therapeutically effective, Dr. James M. McKibbin and Robert P. Scherer of the R. P. Scherer Corporation, Detroit, declared. Changes suggested by the clinical investigators are being incorporated in the commercial production.

Diabetics who have to take injections of insulin daily are expected to benefit from the new almost painless injections.

The new device forces medicine through the skin in so thin a stream that it causes only slight pain, a mild prickling sensation or no pain at all. The hole through which the medicine is forced into the body measures only three- thousandths of an inch, about the size of an average human hair or a mosquito's stinger. As a result scarcely any pain fibers in the skin are stimulated.

Since the medicine never comes in contact with moving parts, there is no need for repeated sterilization. Hazards of dull needles and infection are eliminated.

Material to be injected is put in a new-type metal ampule and a spring-activated plunger exerts the pressure for the spray.

Doctors expect it to be helpful in giving immunizing injections to children who create a scene because of the pain of the usual hypos.

Procaine Penicillin

➤ CRYSTALLINE procaine penicillin G is the latest and most useful form of penicillin. Synthesized for the first time a few months ago and available for general use only since March, it

has already risen to a position of prominence in the medical profession's roster of accepted therapeutic agents, R. R. Umbdenstock of Charles Pfizer and Company, Inc., Brooklyn, N. Y. told the division of industrial and engineering chemistry of the American Chemical Society.

Crystalline procaine penicillin G is only slightly soluble in water and in the body fluids. It is, therefore, injected only by the intra-muscular route usually in the form of a suspension in sesame oil. Being sparingly soluble in the body fluids, crystalline procaine penicillin can be injected in relatively large single daily doses which give up the penicillin to the body at a rate sufficient to maintain detectable blood levels for periods of at least 24 hours in 95% of the patients injected. Thus, the discomfort caused by multiple daily doses is practically eliminated.

Formulations of crystalline procaine penicillin G in oil do not contain beeswax as do other preparations of water soluble penicillin in oil intended for one injection a day therapy. The exclusion of wax in the present formulation has eliminated the most objectionable feature of the penicillin-oil-wax formulations, i.e., the prolonged periods of pain due to the fact that the wax is only slowly absorbed by the body. Because the rate of absorption of the oil by the body is the same as that for penicillin, the entire injection is absorbed in a period of 24-48 hours. Injection of procaine penicillin in oil is virtually painless and can be almost universally used.

By varying several features of the formulation the period of time during which detectable amounts of penicillin are found in the blood stream may be varied from 24 to 96 hours. The formulations which produce detectable levels for 24 hours produce much higher initial blood levels than do the 96 hour preparations. The choice of the formulation rests with the physician and depends upon the individual case.

Insects Cost Four Billions Yearly

➤ FOUR BILLION dollars is the size of the bill rendered the American people by insects because of their damage to crops each year, Dr. H. L. Haller and Ruth L. Busbey of the Department of Agriculture told the American Chemical Society.

This is considerably more than cost of food shipped abroad under the Marshall plan by ECA. (The total ECA expenditure authorized for its first year is slightly more than five billions.)

The government scientists appealed to farmers to increase their protective efforts against insects by use of chemical weapons.

American railroads use more bituminous coal per year than the total amount sold by all retail dealers.

Enough barium salts will soon be mined and produced in Brazil to meet local needs; barites are used in paint pigments.

A Story of Shower Curtains, Plastic Sandwiches and Sour Milk

Progress in Plastics

➤ THAT plastic shower curtain in your bathroom gave the chemists a lot of worries as they were perfecting it.

A plastics age story was told by W. A. Woodcock of the Carbide and Carbon Chemicals Corporation, New York, at the American Chemical society meeting.

When the first plastic curtains were made about a decade ago, the softening agent used in the plastic evaporated too fast. Result: Curtains too stiff and cracked too easily.

Another plasticizer was used and the portion not wet was pliable but the part in contact with water was still too stiff.

A third softening material turned out to be just right—except it developed an obnoxious odor on the store shelf that discouraged customers.

Finally the present shower curtain of vinyl resin was perfected and proved satisfactory.

Then there is the story of the butchers' plastic aprons, made with an experimental softening agent, tested carefully under the usual conditions of a meat market. But they were shipped during a cold spell and arrived at their destination completely shattered because of brittleness.

Mr. Woodcock told these hard-luck stories in reporting the importance of plasticizers, production of which will reach an all-time high this year of 200 million pounds.

Plastic materials get lots of notice but the softening agents necessary in making them are less well known, although a pound of plasticizer is used for every two pounds of vinyl plastics.

Plastics from the Farm

Idle farm products will furnish both plastics and plasticizers of the future, Dr. C. E. Rehberg of the Department of Agriculture's Eastern Regional Research Laboratory, Philadelphia, told the chemists.

Usually plasticizers of vinyl plastics—used in raincoats, handbags, tobacco pouches and dozens of other things as well as shower curtains—are derived from petroleum. Dr. Rehberg reported that softening agents can be made with lactic (sour milk) acid, which can be produced from potatoes, molasses, and sulfite waste liquor from paper making. Other chemicals required can be made from agricultural wastes such as corn cobs.

In this way farms can relieve the oil wells of America in furnishing necessary raw materials.

Plastic-Cloth Sandwiches

A new plastic cloth material is stronger than steel and withstands shell fragments as successfully as armor plate.

Made from common textiles and the polyester type of plastic, the material can be molded into automobile bodies, noiseless gears, water pipes, furniture, boat hulls, and many other useful products. Dr. Milton Galla-

gher and Harold H. Goslen of the University of Chattanooga's Industrial Research Institute and Dr. Raymond B. Seymour, director of special products research for the Johnson and Johnson Company, New Brunswick, N. J. reported the development to the American Chemical Society's paint, varnish and plastics division.

The textiles contributing the greatest strength are woven glass fabric, a synthetic cellulose fiber called Fortisan, tire-cord rayon, nylon, and Steralon, a non-woven cotton cloth originally designed for babies' disposable diapers. Pound for pound, the multilayered sandwich of textile and plastics is reported twice as strong as structural steel.

In a long series of tests financed by the Office of Naval Research, sandwiches, or laminates, of polyester plastics and every commercially available textile were prepared and studied.

The material is prepared by draping a piece of cloth over a mold. A liquid plastic is poured over the cloth and spread out like so much jelly on a piece of toast. Alternate layers of plastic and cloth are applied, until a sandwich of the desired thickness has been built up. Finally, the molded material is subjected to moderate pressure and immersed in hot water for a few minutes to make it harden.

Plastic laminates have long been used for table tops, electrical insulation, and machine parts. These articles have been made with a different type of plastic which requires long molding times and high temperatures, and, in addition, the laminated materials have been comparatively weak.

With the new material, because high pressures and temperature are not necessary, large, complicated structures that were previously impossible can be made.

Experimental automobile bodies, airplane fuselages, and boats have been made using this new technique.

Polyester resins were developed just before World War II. Laminates, notably that with glass cloth, were immediately put to use, but not until after the war was there an opportunity to determine the full scope of the plastic's possibilities.

While every available textile was investigated during the research project conducted at the Institute for Industrial Research, only glass fabric, Fortisan, tire-cord rayon, and nylon were of sufficient interest to warrant additional study, the chemists stated. Outstanding results were obtained also when textiles made by a new non-woven process were used.

Plastic laminates reinforced with Fortisan fabric were five times stronger than those reinforced with cotton. Yet, chemically, both reinforcing members are very simliar cellulose molecules. Fortisan is made from cellulose acetate fibers which are stretched and then decomposed to cellulose. The arrangement of fibers, called orientation, made possible by this stretching process, causes the fibers to be many times stronger than cotton fibers.

Some improvement over cotton was obtained with rayon tire-cord which was also oriented. Tensile strengths as high as 45,000 pounds per square inch have been obtained with Fortisan laminates, while the best results

for those from tire-cord and cotton have been 22,000 and 6,500 respectively. Linen and ramie, naturally occurring cellulosic fibers, gave laminates having tensile strengths greater than cotton but much less than the man-made cellulose fibers, Fortisan and tire-cord rayon.

Inorganic fibers such as asbestos gave very low tensile strength but possessed desirable flame resistance characteristics. Glass fibers were outstanding but again, as in the case of the cellulosics, the strengths have been deveolped through orientation of the fibers. The best tensile strengths obtained for laminates made from glass fabrics were slightly under 40,000 pounds per square inch. This is actually 50 per cent less than that of structural steel, but since steel weighs four times as much as the plastic laminate, the latter is actually twice as strong on a weight basis.

One might assume that a wedding of steel and plastic might yield interesting progeny, but it was found that laminates made from stainless steel cloth were only about as strong as linen-plastic combinations.

Many other properties, such as flexural strength, compressive strength, water absorption and hardness have also been determined, since the tensile strength is only one of many properties and actually of minor importance for such applications as armor plate.

Many synthetic fibers have been developed in recent years and these were also investigated intensively. The protein fibers from casein, soybeans or peanuts are somewhat similar to wool and give plastic laminates of low strength. Fabrics from cellulose acetate, Saran, Vinyon, Vinyon N and nylon all tended to melt when in the molding operation. Products having interesting appearances were obtained with these materials and while each had characteric desirable properties, only nylon seemed worthy of further investigation. Plastic laminates from nylon had tensile strengths of 20,000 pounds per square inch. Those from cellulose acetate had tensile strengths less than 4,000, although it will be recalled that those from Fortisan, which was cellulose prepared from cellulose acetate, were ten times as strong.

Zinc Lack Stops Plant Growth

➤ ZINC IS NEEDED in microscopic quantities by plants to promote normal growth. This role of the metal in plant nutrition has been proved by researches conducted in the botany laboratories of the University of Wisconsin by Dr. Cheng Tsui.

Tomato plants grown in a culture solution without the slightest trace of zinc grew a few inches, then stopped. When a little zinc was added, they resumed growth and eventually became almost normal.

Zinc-deficient plants were found upon analysis to be very short of the natural growth-promoting substance known as auxin, and also to be short in the protein building-block, tryptophane, from which auxin is formed in the plant. The direct effect of zinc lack appears to be in blocking the synthesis of tryptophane.

High-Temperature Carbonization's Cyclopentadiene—Versatile Chemical

Drying Oil, Ether, Floral Odors, Resins

➤ A CHEMICAL known as cyclopentadiene, obtained from coal by a high-temperature carbonization process, probably produces more versatile chemical reactions than any other hydrocarbon except acetylene. It can now be used in making drying oils for paints, powerful floral-type odors, an internal ether having properties resembling menthol and certain rare chemicals, as well as for resins and plastics.

Some of its newer derivatives, uses and applications are described by Herman A. Bruson of Resinous Products and Chemicals Co., Philadelphia. It has been known in the past principally for its use in making synthetic resins and plastics, including a rubber-like material.

Upon standing at room temperature for 48 hours, cyclopentadiene "dimerizes" to a crystalline chemical called di-cyclopentadiene, and no method has been found to prevent this reaction for more than a few days except refrigeration in the dark. Dimerizing is a chemical reaction in which a new product is formed by the union of two molecules of a compound.

Alcohols and phenols readily add to dicyclopentadiene to form ethers. The unsaturated ethers prepared from dicyclopentadiene and glycols rapidly absorb oxygen from the air and form insoluble, hard, resinous films, resembling linseed oil in this respect. Synthetic drying oils are obtained by adding unsaturated fatty acids to dicyclopentadiene.

The reaction of allyl alcohol and cyclopentadiene yields an internal ether having marked physiological properties resembling menthol and capable of opening the nasal passages when inhaled. The unsaturated ethers prepared from dicyclopentadiene and certain alcohols, such as methyl and ethyl alcohols, have powerful floral type odors, and are readily obtainable in high yields.

New B-Group Vitamin

➤ DISCOVERY of a new vitamin, believed to be a member of the vitamin B group, has been announced by Prof. S. M. Hauge of Purdue University.

Existence of the vitamin was first suspected in studies on chicks. Later work leading to positive knowledge of its existence was done with rats. It is a growth factor for rats, chicks and a micro-organism, Lactobacillus arabinosis, but what human use it may have was not reported. The vitamin was discovered in an animal food called distillers' dried solubles which is derived from distillery wastes. This material and also condensed fish solubles may contain still other growth factors, or vitamins.

Today's Opportunities for Women Trained in Chemistry

Women in Chemistry

When war conditions created an unprecedented demand for chemists and a scarcity of men, women with chemical training found themselves appreciated as never before. At the end of the war they were asking, "Will it last?" Many inquiries of this nature came to the Women's Bureau of the U. S. Department of Labor. There was little information to draw on for an attempt to forecast the future for women chemists.

As part of a wider survey of employment of women in scientific work, Marguerite Wykoff Zapoleon of the Women's Bureau, with the assistance of Elsie Katcher Goodman and Mary H. Brilla, gathered data and wrote a bulletin which is a complete round-up of past, present and probable future trends in employment for women in positions where chemical training is necessary.

The future outlook is promising, according to the reports from scientific organizations, Federal agencies and private industries which furnished information for the bulletin. Excerpts reprinted here give an idea of how the subject is covered, but those interested in chemical jobs for women will want the whole bulletin. It should especially be in the hands of all who counsel girls toward employment opportunities.

THE OUTLOOK FOR WOMEN IN CHEMISTRY, *Bulletin 223-2 of the Women's Bureau, Department of Labor, may be obtained from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. at 20 cents per copy.*

➤ CHEMISTRY easily outstrips all the other sciences in its employment of women, and also of men, if the applied sciences of engineering and medicine are excluded. In 1946, between 5,000 and 6,000 women chemists, with at least the bachelor's degree or its equivalent in experience, were employed in chemical laboratories or in related work in the United States. The proportion of all chemists who are women is relatively small, however, roughly 6 per cent or 1 out of 16. In astronomy and mathematics as well as in the principal biological sciences, the percentage women form of all those employed is higher than in chemistry. However, the number of women in all these fields combined is less than the number of women in chemistry.

Because World War II created an insatiable demand for chemists and at the same time diverted into military service many of the men available for laboratory work, women chemists were prized, and young women were urged to train for chemical laboratory work.

At the end of the war, as men returning from service resumed their jobs in laboratories or their college training, women began to ask:

➤ WOMAN CHEMIST *in the National Institutes of Health analyzes organic compounds by the combustion method.*

Will the demand for women chemists continue at wartime levels?

Has the increase in the number of women in chemistry during the war improved or reduced the employment chances of college women training for chemical work?

Are there certain chemical fields which offer greater opportunity for women than others?

To answer these and similar questions, it is necessary first to look backward to see how women chemists fared before the war. . . .

The general belief that most women chemists in laboratories are engaged primarily in the analysis or routine testing of raw materials, finished products, or goods in process, while most men chemists are engaged in research, is apparently true if all chemists are considered. However . . . even before the war the proportion of experienced women chemists who were engaged in analytical work was actually lower than that of a comparable group of men. The explanation may be found by looking at the less experienced group of women. A much higher proportion of them, about one-fourth, were doing analytical work, usually in hospital or other medical laboratories rather than in industry.

The chief differences in the type of

employment of men and women chemists before the war were: the lower proportion of women in industrial research, their lower proportion in administration, and their higher proportion in teaching. The higher proportion of women chemists in chemical library and information service was also significant.

More marked than the differences in the kind of work done by men and women chemists before the war were the differences in the type of establishments in which they worked. Almost two-thirds of the men members of the American Chemical Society, excluding those in chemical engineering, reported that they were employed by private industrial firms in 1941; but only one-fourth, roughly, of the women chemists were working in industry. For the women, Government and educational agencies were more important sources of employment. Less than 3 per cent of both women and men chemists were self-employed in consulting work. In this they differ from those engaged in such professions as law and medicine, where private practice predominates. . . .

Increase in Demand

World War II transformed this picture suddenly. As early as 1942, and rising to a peak in 1943-44, the demand for women trained in chemistry became not only fantastic in relation to the supply available but virtually nondiscriminating. According to reports from the colleges, the poorest student in chemistry had an almost infinite choice of jobs. A southern school which had never had any calls for women graduates in chemistry before the war reported 353 openings in 1944. An experienced woman chemist, interested in changing positions in 1944, was interviewed by 71 employers at a meeting of the American Chemical Society at which an employment clearing house was conducted for members. Previously unheard-of calls for girls with a course in high school chemistry to work as laboratory assistants were received by high school placement bureaus, as early as 1942. . . .

After the War

At the close of the war, in 1945, chemists with at least the bachelor's degree or its equivalent in experience probably numbered about 75,000. This figure was reached by adding a 4,000 allowance for additional graduates in 1944 and 1945, minus withdrawals for death or retirement, to the Bureau of Labor Statistics' estimate of 71,000 civilians employed in chemistry, exclusive of chemical engineering, at the end of 1943. In addition, there were at least 10,000 chemists in military service and about the same number of persons with partial training or experience in chemistry below the bachelor's level. From 5,000 to 6,000 of all chemists were women, who formed more than 6 per cent of the total in 1945, as compared with 3 per cent before the war.

Although the statistical evidence of the increased opportunity for women chemists in wartime and the resulting increase in their numbers is convincing, many women chemists warned against over-enthusiasm. One woman chemist called attention to the prejudice which she asserted continued to exist. Another commented on the high earnings in war industries, but warned that the work was routine and offered little opportunity to learn.

She said, "Your employer regards you as something he picked up on the bargain table; and your men associates regard you as an intruder in their domain." A number questioned the "wonderful opportunities" resulting from the war, observing that these opportunities were chiefly in control laboratories and that few women were given greater opportunity to do original research. . . .

More than a year following VJ-day, indications were that the number of women chemists had more than tripled as compared with 1940, and that their proportion among all chemists had doubled. At the end of 1946, 6 per cent of the members of the American Chemical Society and almost 7 per cent of the chemists registered with the National Roster of Scientific and Specialized Personnel were women. Although a decrease in the employment of women chemists in industry and Government took place as the demands of war ceased, and the new recruiting of additional women practically ceased, the decline in the employment of women in chemistry was relatively small leaving a large net increase over the prewar years. . . .

Suggestions to Students

In any occupation, one finds optimists, pessimists, and the realists whose experience and temperament enable them to evaluate the advantages in relation to the disadvantages. Because chemistry has been in the main a man's field, there are those who say, as one head of a chemistry department in a State college has—

> Advise girls interested in chemistry to stay out. But if they insist, advise them to prepare for a field in which women have an advantage rather than a handicap.

According to this advice, only the girl with a driving interest, combined presumably with ability in chemistry, should be encouraged to become a chemist, and she should be steered toward foods, textile, or cosmetics chemistry; biochemistry; analytical chemistry; or toward work as a technical librarian, patent searcher, or technical secretary. Spectroscopy and microchemistry are more recently emerging specialties in which women have an advantage.

A woman chemist, on the other hand, wrote optimistically in 1945:

> The woman who enters the industrial chemical field today has just as much assurance as a man of obtaining profitable and interesting employment. Her career will be determined by the quality of her initiative and courage.

The majority of the employers, college representatives, and women chemists interviewed in connection with this study predicted a steadily increasing and widening opportunity for women chemists but stressed the importance of being well-qualified. By well-qualified they meant better qualified than a man would need to be for the identical job, in order to offset the handicaps already discussed. The basic qualifications for success in chemistry are fully described in publications of the National Roster of Scientific and Specialized Personnel and of the American Chemical Society. Only those mentioned as being especially important for women, therefore, are included in this bulletin.

The head of an important Government laboratory said that, if he were

advising his daughter to prepare for work as a chemist, he would tell her that she:

must attain manual dexterity in handling equipment equivalent to the standards of men;
must learn to look at a problem in its broadest aspect;
must learn the habit of hard work in absorbing and thinking through concepts and formulae.

Two employers, one in Government and one in industry, likened the good chemist to a good cook. Imagination, the use of a variety of ingredients, exactness, the ability to keep many pots cooking at the same time, resourcefulness—all these are needed by cooks and chemists. The cook who lets the stew burn while she talks to her neighbor is like the chemist who can't set up and control more than one experiment at a time.

Women chemists almost all mentioned the desirable traits of co-operativeness, adaptability, and a serious attitude toward one's job as ranking equal in importance to training and experience not only in obtaining employment for oneself but in smoothing the path of those who come after.

A woman should not seek a research or other responsible job, if she does not intend to work for more than two or three years. On the other hand, if she is interested in chemistry as a career and intends to keep up with it come what may, she should give evidence of this interest through further study, through participation in professional organizations, through discussion with colleagues, through writing. Only in this way can she counteract the erroneous notion that all men show a more serious attitude toward their work than do all women. Whether she falls in the short-run or long-run interest group, she should maintain certain ethics in relation to her work.

The three women who left a laboratory in a foods company one after another after only a few months of service have closed that position to women as long as the present head of the laboratory is in charge. The technical secretary who left a metal products company without notice to take a three-months' trip with her husband on his return from military service left in the laboratory a resentment that will affect the chances of women not only in her former job, but throughout the laboratory. Two women chemists who left a testing laboratory with only a few days' notice in 1945 were replaced by men, although the head of the laboratory was a woman. Women in scientific work must recognize the obligation not only to perform the job well but to accept the responsibilities that go with such employment.

Regarding training, a number of suggestions were made. Many employers commented that most women applicants didn't have enough courses in chemistry. Women chemists and placement directors stressed the need for more mathematics and physics along with chemistry. Training in report-writing and in oral reporting was recommended. Typewriting and stenographic skills were also suggested as being useful on laboratory as well as nonlaboratory jobs. For research, for technical library work, or for literature searching, German, French, and Russian were mentioned as desirable languages.

Electro-Chemistry - III

Electrolysis—(Part 2)

by Burton L. Hawk

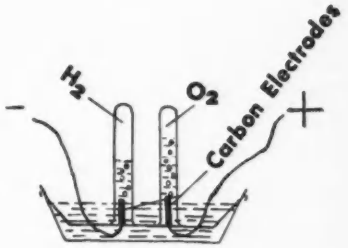
➤ There are two general methods of acquiring knowledge: (1) by studying the opinions and findings of others; (2) by actual experience and personal observation. The latter method is particularly applicable to the study of science.

Let us consider the composition of water. We have read in chemistry textbooks that water consists of two parts hydrogen and one part oxygen. This is simply accepting the findings of others; let us actually *prove* this statement to our own satisfaction.

Electrolysis of Water

The best way to determine the composition of a substance is to decompose it into its component parts and then identify each one. With water, we can accomplish this by electrolysis.

As water does not conduct the electric current, a small amount of sulfuric acid must be added to make a conducting solution. Set up an apparatus similar to the one shown. A shallow pan or trough is filled partly with the solution. Two test tubes or narrow bottles are also filled and inverted in the solution in the trough. Finally the electrodes from a source of direct current are inserted — one in each tube. Four dry cells should provide sufficient current for this demonstration. The electrodes should be of platinum, but if your supply of



this metal is exhausted, strips of carbon (pencil leads) will suffice.

As electrolysis is begun, you will notice bubbles of gas arising from the electrodes which will gradually displace the water in the tubes. You will notice also that twice as much gas is obtained from the negative electrode as from the positive. If the textbooks are correct, this must be hydrogen.

Finally, when all water is displaced, stopper the tubes quickly and then remove from the solution. Now we should have hydrogen in the negative tube and oxygen in the positive. Invert the tube of hydrogen, remove the stopper, and hold over an open flame. A sharp explosion will confirm the identity of hydrogen. Remove the stopper from the oxygen tube and quickly insert a glowing splinter. The splinter will burst into flame thus proving the presence of oxygen.

Therefore in reality we have proved that water consists of hydrogen and oxygen in the ratio of 2 to 1. We

have learned something through personal observation and findings. Such is the purpose of experimenting.

Metals by Electrolysis

By passing an electric current through a solution of silver nitrate, metallic silver can be obtained. Allow the carbon electrodes to dip in the solution. You can actually see crystals of silver growing on the negative rod.

Copper may be obtained in a similar way from copper sulfate solution. In fact, most of the less active metals can be obtained in this manner: lead, tin, mercury, gold, etc.

The metals will always be liberated at the negative pole. Can you determine by experimentation alone (without reference to any text books) what is liberated at the positive pole?

The more active metals cannot be liberated from their aqueous solutions by electrolysis. As we explained in detail last month, the electrolysis of sodium chloride solution will not produce sodium. Here it is necessary to electrolyze the sodium chloride in a molten state to obtain the metal. This requires an extremely high temperature and a strong current of electricity and is not recommended for the home lab.

Commercially, both sodium and chlorine are produced by the electrolysis of molten salt. Potassium is obtained by the electrolysis of molten potassium hydroxide.

Calcium, barium and strontium can also be obtained by electrolyzing the fused chlorides.

Aluminum is obtained by the electrolysis of a solution of aluminum oxide in fused cryolite.

Magnesium can be obtained by electrolyzing a fused mixture of magnesium, sodium, and potassium chlorides; or by electrolysis of magnesium oxide dissolved in fused magnesium fluoride.

Thus we see the important role electricity plays in the production of many vital metals.

Our study of electrolysis would not be complete without a consideration of electro-plating. This we will discuss at some future date.

Motion Pictures In Full Color

▶ PRINTING MOTION pictures in full color, by a new process of Polaroid Corporation, produces three separate color images on a single layer of standard black-and-white film from three color separation negatives.

The new process is known as Polacolor. Use of this standard film and essentially the same processing equipment employed in black-and-white movies makes the process relatively inexpensive. The new full-color movies are suitable for showing in standard projectors.

Printing the three color images is effected by conventional devices. All the film materials, chemicals and processing agents are available commercially. The Polacolor silver sound track is exposed and developed along conventional lines and has the same characteristics as conventional sound tracks for black-and-white moving pictures.

Hormones and Enzymes Control Lives, Emotions and Health of All of Us

Potent Chemicals of the Body

The exploration of the chemistry of the powerful secretions and processes of the animal body is a continuing adventure story told whenever the American Chemical Society meets.

Synthetic Female Sex Hormone

➤ CHEAPER and more abundant supplies of a female sex hormone of great therapeutic value are promised by a synthetic process developed in Germany during the war.

Dr. H. B. MacPhillamy of Ciba Pharmaceutical Products, Summit, N. J., explained to the American Chemical Society that as a starting point, the method utilizes chloesterol, an alcohol occurring widely in nature. The final product is the hormone estradiol. From a clinical standpoint estradiol and its derivatives are the most important of the female hormones used to treat women in the difficult transition period of middle age.

The yield first reported for this synthesis was quite low, but more recent reports indicate that this method may soon provide the hormone more cheaply and more readily than the present laborious technique of extraction from urine.

At present there are two groups of estrogenic substances on the market. One group comprises those substances which are found in the animal under normal physiological conditions, together with certain of their derivatives. The other is made up of synthetic substances which, although not present in the organism, do produce the same or at least a very similar response to that of the natural estrogens. These have provided keen competition, but the greater frequency with which undesirable side reactions occur has led to a continued demand by the medical profession for the natural product.

Estrogens appear to be formed in the ovaries under the stimulation of the secretion of gonadotropic hormones from the anterior lobe of the pituitary. They control the growth and physiological function of the female reproductive organs and also the development of the secondary sex characteristics. During pregnancy, relatively large amounts of estrogens are excreted in the urine and it was from the urine of pregnant women that in 1929 Doisy and his co-workers in this country and independently Butenandt in Germany isolated the first pure crystalline estrogenic hormone, estrone.

Soon afterwards it was observed by Zondek that the urine of pregnant mares contained relatively large quantities of estrogens, and it is from this source that most of the commercially prepared estrone is obtained. It has been calculated that one mare during pregnancy excretes as much hormone as would be excreted by 1,500 pregnant women; and 25 grams of crystalline material. These estrogens are excreted in the form of water soluble

conjugates; in the urine of pregnant women as glucuronides and in that from pregnant mares as sulfates. These are quite stable substances and, although they are relatively inactive when given by injection, they do show considerable oral activity.

Later investigations have shown that estrogenic substances occur quite widely in nature. Surprisingly enough, the ovarian hormone occurs in extremely large amounts in the urine of the male members of the equine species, that is the horse, zebra, donkey, and so forth. This seems to be very specific and has not been encountered in any other animal group. In fact, the testicles of the mature stallion have the highest known concentration of estrogen of any tissue, about 500 times as much as the ovaries of a mature woman. Estrogens have also been isolated from the placenta and some commercial preparations are made from this material.

Estrogens have also been found in some of the lower forms of animal life and in the plant kingdom. For example, estrone has been isolated from palm kernel extract and estriol from pussy willows.

Clinically estradiol and its derivatives are the most important of this class of hormones. It has the highest potency of any of the estrogens occurring naturally and possibly represents the true ovarian hormone as it is produced by the gonad. However, it is evidently metabolized very rapidly, since only small amounts are excreted in the urine. The other natural estrogenic hormones are considered to be metabolic products of estradiol; in the human, estrone and estriol; in the horse, estrone and the equinine hormones, equilin and equilenin.

Since estradiol is destroyed in the body so rapidly, the duration of its therapeutic effectiveness is quite short. Several active derivatives of estradiol have been prepared which are absorbed quite slowly from the site of administration, thus increasing the duration of the biological response. The derivatives most commonly used are the monobenzoate, the dipropionate and, more recently, ethyl estradiol. This compound is one of the most potent estrogens known and has the great advantage that it may be given orally.

Commercially, estrone is prepared by hydrolyzing pregnant mares' urine with acid to split the conjugate, and then the crude estrone is either extracted with a water insoluble organic solvent such as ether, or absorbed on and eluted from charcoal or some other suitable absorbing material. Preliminary purification takes advantage of the fact that estrone is a weak acid, and hence by treating a non-aqueous solution of the hormone with a weakly alkaline solution, the strongly acidic impurities are removed. The estrone may then be extracted with a strongly alkaline solution leaving the neutral impurities behind. More recently, this process has been improved by stirring an anhydrous solution of the hormone in an organic solvent with solid alkalies of varying strength. The same separation is effected, but much more efficiently.

Final purification of estrone is readily accomplished due to the fact

that it forms an insoluble salt with quinoline and thus it is separated from the accompanying impurities, equilin and equilenin, which do not form such a compound. The crystalline estrone so obtained together with some of the less pure estrone concentrates are used clinically. This is also true of estrone sulfate, the water soluble conjugate manufactured directly from pregnant mares urine.

Synthesis of Cyclohexestrol

➤ Among the various substances produced in the body for the purpose of controlling specific physiological functions is a group known as the estrogenic hormones. In the cycle of sexual changes which occur in the female, the action of these complex molecules brings about the correct physiological conditions with the desire for mating and procreation. Ever since the isolation of the first of these substances in 1930, the need for such hormones in medical practice has been realized and today, although rare and expensive, they are available to doctors everywhere.

The estrogenic hormones exert such specific action in controlling these complex physiological changes that it was of great interest when in 1933, Cook, Dodds and Hewett of the Courtauld Institute of Biochemistry in London found that other organic compounds showed the same activity. Such compounds were not of natural occurrence in the body but could be synthesized in the laboratory because they were of simpler structure. Research in chemistry and physiology since the discovery has turned up several hundred organic compounds, some simple and some complex, which are not produced in the body but which have to greater or less degree this estrogenic activity.

Chief among these for their activity and general success in therapy are the compounds known as diethylstilbestrol and hexestrol. These are sold everyday under prescription and have various trade names. Nevertheless the successful use of the compounds raises other questions for the chemist, questions which apply to every drug: What makes this drug active in the way that it is? Can it be improved upon?

In trying to answer these questions chemists and biologists work out new compounds, new formulas. The number of synthetic estrogenic compounds grew from one to hundreds.

In another attempt to turn the stone that might provide an answer to these questions a new molecule was synthesized which because of its close similarity to hexestrol might be called cyclohexestrol. Prof. George P. Mueller and Roy May of the University of Tennessee reported to the American Chemical Society on this work.

Hexestrol itself possesses a chain or string of six carbon atoms as part of its structure. Attempts to shorten or lengthen this chain or to change the position of the various atoms attached to it have resulted in a less active drug. It might therefore be assumed that this chain is greatly responsible for the physiological activity of the entire molecule. One simple modification of this chain had not been examined, however. That was to tie the ends together, making a cyclic instead of open chain type of mole-

cule. This was accomplished in a series of chemical transformations and cyclohexestrol resulted.

When subjected to physiological testing in rats this new compound shows estrogenic activity, but again it is far less potent than hexestrol itself. Thus it appears again that modification of the straight chain of carbon atoms has resulted in a less active compound.

Adrenal Cortex Hormones

➤ ADRENAL cortical extracts have been found to be of value in the treatment of human adrenal insufficiency, the most severe and unique manifestation of which is known as Addison's disease. In addition, there is an increasing interest in the clinical use of adrenal cortical hormones in various conditions where there are abnormalities of carbohydrate metabolism and electrolyte and fluid balance attributable to hypo-secretion of the adrenal cortex.

A paper on this subject was presented by M. H. Kuizenga and W. J. Haines of The Upjohn Company, Kalamazoo, Mich., presented before the divisions of industrial and engineering chemistry, biological chemistry, and medicinal chemistry, at the Washington meeting of the American Chemical Society.

Our present knowledge of the usefulness of adrenal extracts in clinical conditions of adrenal insufficiency has been made possible by biochemical studies with adrenal tissue which have resulted in the preparation of biologically potent extracts. The deficiencies which such extracts correct, and which involve carbohydrate and electrolyte metabolism, invariably lead to death of the organism. The prevention of death after adrenalectomy was indeed the first objective which early investigators strived to attain by the extraction of adrenal glands.

Probably the first observation that adrenal extracts could alleviate symptoms of insufficiency of the gland were made in 1896 by Osler, who used a glycerin extract of pig adrenal in a patient with Addison's disease. After the isolation of epinephrine from the adrenal medulla, it was shown that this hormone was incapable of maintaining completely adrenalectomized animals. Although glycerol and saline extracts of adrenal glands were capable of partially prolonging the life of animals without adrenal glands, satisfactory maintenance during the entire period of administration was not obtained until it was determined that the hormone could be extracted with fat solvents and that toxic water soluble substances such as epinephrine could be removed.

Since beef adrenal glands were available from the packing houses in larger amounts than those of other animals, these were used first in studying methods and making large-scale application of procedures for production of adrenal cortical extracts. This process involves the extraction of glands with acetone, the removal of the acetone and extraction of the resulting aqueous solution with petroleum ether or gasoline which removes non-hormone containing lipids.

Subsequent extraction of the aqueous solution with ethylene dichloride then obtains the hormone fraction which can be further purified by distribution between aqueous alcohol

and Skelly Solv. Acidic and basic material is finally removed from an ethyl acetate solution of the material from the aqueous alcohol phase. According to this procedure, publication of which has been made in several scientific papers, 1,000 pounds of beef adrenals yield about nine grams of whole gland extract of highest purity. Such material is used in the preparation of commercial adrenal cortex extract.

By further fractionation and chemical separation of the purified gland concentrate in several laboratories, many crystalline substances have been obtained, six of which have been found to be biologically active when tested in adrenalectomized animals. These six compounds have been identified as steroids and their chemical structure proved. Four of these compounds which have their primary effect upon carbohydrate metabolism occur in greater quantities in the gland extracts than do the other two compounds which have a primary effect upon electrolyte metabolism. The comparison of extracts from beef, hog and sheep adrenal glands yield further confirmation that the important constituents of natural extracts are those substances which have their primary effect on carbohydrate metabolism. It was further found that hog adrenal extracts were more potent than beef or sheep adrenal extracts. The compound which has the highest degree of biological activity as determined by work performance and glycogen deposition tests is 17-hydroxycorticosterone which appears to be the chief bio-active constituent of hog adrenal extracts.

The use of hog adrenals, as well as beef, has therefore become important in the commercial preparation of adrenal cortex extract. The size of the hog adrenal is only about one-fourth that of beef but the fact that the yield of hormone is about double and the animal kill about three times that of beef made this source one to be considered. The high fat content of hog adrenals necessitated an alteration in the extraction process in that greater care must be taken to assure complete extraction of the hormone from the fat.

Desoxycorticosterone, which can be considered as the most active "salt and water hormone," is the only adrenal cortex steroid for which a practical synthesis has been practiced commercially using either stigmasterol or cholesterol as starting material. In spite of the high activity of desoxycorticosterone in preventing sodium and fluid loss, which apparently is one of the functions of adrenal gland secretions and is also one of the properties of whole gland extracts, the compound cannot be detected in any significant amount in gland extracts. There is good evidence that other substances are present in adrenal extracts which have a desoxycorticosterone-like effect.

In any condition of stress, animals without adrenals will quickly fail in spite of desoxycorticosterone therapy. What is then required is the gland extract of one of the steroids effective in carbohydrate metabolism. Much progress has also been made on the syntheses of these steroids. Three of them have been obtained by degradative synthesis from desoxycholic acid. The synthetic preparation has not progressed, however, to the stage of practical manufacturing procedure.

The synthesis of the most active steroid by carbohydrate function tests, 17-hydroxycorticosterone, has not yet been reported, but by alteration of the methods of preparation of the others, this compound can probably also be obtained.

The synthetic preparation of these compounds is a highly costly one and, although one looks forward to possible lower cost of adrenal cortical hormone therapy by the successful application of synthetic methods, we are at present dependent upon whole gland extracts. The synthetic preparation of all the adrenal cortical substances will be dependent on further isolation work. Unidentified substances may still be present in the "amorphous fractions" which are responsible for its activity and thus should be considered in any synthetic preparation intended as an adequate substitute for natural adrenal hormones.

How Liver Controls Fat

➤ CELLULAR "power plants" in the liver control the body's utilization of fats. Dr. Albert H. Lehninger of the University of Chicago, 1948 winner of the Paul-Lewis Laboratories Award in Enzyme Chemistry, told the American Chemical Society about the system of enzymes, or chemical regulators of life processes, which promote the conversion of fatty acids to energy that are found to be localized in small granules near the surface of liver cells.

"These particles possess most of the respiratory machinery of the liver cell and might therefore be regarded as cellular power plants," he said. "The enzymes and chemical intermediates involved in the oxidation of fatty acids in the tissues of the body have not been very well understood in the past because the enzymes responsible for catalyzing this process were found to be so unstable that they could not be studied in the test-tube in cell-free tissue extracts."

The research reported showed that these enzymes can be activated by the addition of certain coenzymes so that the enzymic activity can be readily studied independent of the intact cell. Dr. Lehninger described the results as follows:

The enzyme system which catalyzes the oxidation of fatty acids to acetoacetic acid and ultimately to carbon dioxide and water in the liver and other tissues requires the presence of adenine nucleotides, magnesium and certain other neutral salts, catalytic traces of oxalacetate, inorganic orthophosphate and cytochrome-c. In the absence of any one of these components the enzyme system is inactive.

The enzyme oxidizes the higher fatty acids, both saturated and unsaturated, with either an odd or an even number of carbons in the chain. The main product is acetoacetic acid. If sufficient oxalacetic acid is present the reaction proceeds to complete combustion to CO_2. This occurs by enzymatic reaction of 2-carbon intermediates formed during fatty acid oxidation and oxalacetate to form citric acid and eventually carbon dioxide via Krebs tricarboxylic acid cycle.

The function of inorganic orthophosphate and adenine nucleotide in enzymic fatty acid oxidation is an

energy-transmitting mechanism. As the fatty acid is oxidized, energy is liberated and is conserved by the formation of so called high-energy phosphate bonds of adenosine triphosphate. This was established by the use of P^{32} as a tracer.

These investigations represent only a beginning toward a complete understanding of the enzymes and mechanism of fatty acid oxidation, but with the finding that this process can be studied free of the intact cell, such research will be greatly facilitated.

Dentists Change Tooth Composition

► DENTISTS can now change the composition of your teeth, to make them resist decay. Sodium fluoride is applied to the surface of the teeth.

Research showing that sodium fluoride, a compound used extensively for the prevention of cavities, produces its effect by replacing some of the phosphate in teeth with fluoride, was described to the American Chemical Society by Howard A. Kirshner, Albert E. Sobel, Albert Hanok, and I. Fankuchen of the Polytechnic Institute of Brooklyn and The Jewish Hospital of Brooklyn.

That such changes are desirable is indicated by the lower solubility of fluoride-treated teeth in acids, as shown by other scientists, the chemists reported. These acids, produced by bacteria in the mouth, are responsible for most types of tooth decay.

Previous studies by the Brooklyn research group have demonstrated that diet influences tooth composition. Such factors must be understood if dental decay is to be effectively controlled.

"It is estimated that over 90 per cent of the population of the United States suffers from some form of tooth decay," the paper stated. "This widespread prevalence of caries poses a public health and national security problem. Many branches of the armed forces in World War II were faced with the choice of either lowering their standards or eliminating many otherwise desirable men because of bad teeth."

Although tooth composition varies widely among individuals, the crystalline structure of teeth is always the same. This structure, moreover, appears to be unaffected by sodium fluoride.

The crystalline structure was studied by the x-ray diffraction technique, in which the x-rays enter the crystal and show the arrangements of the various atoms with respect to one another, it was explained.

Unfortunately x-ray techniques at present do not show changes on the outer surface of crystals. Therefore, the possibility of changes in crystalline structure on the surface has not been eliminated.

A new German drug called marsinal, captured among other medical supplies, is understood to be a member of the sulfa group and intended for use in the treatment of gas gangrene.

Medicines With Strange Names Help in Heart and Blood Ills

New Drugs For the Heart

➤ A "POWERFUL DRUG" for treating heart disease was announced at the meeting in Chicago of the Interamerican Cardiological Congress.

"Distinct improvement" in 140 of 250 patients and "moderate improvement" in another 85 patients given daily doses of the drug were reported by Dr. M. R. Kenawy of Cairo, Egypt. Only 25 of the group showed no benefit.

The drug is called khellin. It is extracted from the fruit of a plant growing in the Middle East. The fruit is called Amni visnaga.

Khellin is a powerful dilator of the blood vessels of the heart. Constriction of these blood vessels, with decreased blood supply to the heart muscle, is the trouble in some kinds of heart disease. Khellin's dilating action is very prolonged, lasting for many hours. It is apparently nonpoisonous.

Because of its antispasmodic action, khellin also has been found suitable in treatment of bronchial asthma.

For clearing the swelling, or dropsy, in advanced heart failure, lots of water, some acid and a moderate reduction in salt are needed, Dr. F. R. Schemm of Great Falls, Mont., declared.

This treatment scheme succeeded in four-fifths of 322 instances. But in 160 other instances, the swelling was not cleared when only two of the three measures were used. No two succeeded alone, even when salt was completely removed from the diet, or as much as eight quarts of water was given daily, or when heavy doses of acids were given with one or the other measure. But much less drastic salt restriction, acid doses and water drinking when used together produced "dramatically" good results.

Dihydroergocornine

➤ A NEW DRUG for treating high blood pressure which looks "promising" in preliminary trials was announced at the Interamerican Cardiological Congress.

The drug is called dihydroergocornine. It comes from ergot, drug long used to check hemorrhage in childbirth. Preliminary trials of it in patients with high blood pressure were reported by Drs. Ralph M. Tandowsky and Fred V. Cerini of Los Angeles.

Its action is based on functional blockage of sympathetic nerve impulses to the very smallest arteries. It is given daily by injection into a vein until the ideal blood pressure for the patient is reached. If results prove satisfactory it is then given in a liquid to be swallowed each day to keep the blood pressure at the desired level.

The new drug is not considered a cure for high blood pressure. The Los Angeles doctors call it a valuable aid in relieving the condition. It must be given with caution as it tends to be cumulative and this frequently agitates the patients with high blood pressure.

A nerve-cutting operation to reduce high blood pressure may, contrary to previous medical opinion, be helpful in patients whose high blood pressure is complicated by heart failure.

Definite improvement for a long period has been obtained in eight of 11 such patients operated on, Drs. Ignacio Chavez and Luis Mendez of Mexico reported.

Heretofore heart disease and especially heart failure have been considered definite signs against the operation, though patients with this complication are precisely the ones who most urgently need lowering of the blood pressure, the Mexican physicians pointed out.

When medical treatment failed, they were forced to operate on such patients, some of them in extreme heart failure.

The improvement in the eight patients who survived the operation has lasted from one to two and a half years without further sign of heart failure. Some of them have resumed normal life.

Anti-Clotting Chemicals

▶ STRIKING IMPROVEMENT in the outlook for patients with a common form of heart disease comes from the use of two modern anti-blood clotting chemicals, heparin and dicumarol.

This is the verdict of a committee of the American Heart Association presented by its chairman, Dr. Irving S. Wright of New York, after reviewing the evidence in 800 cases. It is a verdict many physicians have been awaiting before daring to use the drugs for their own patients.

Treatment with these drugs, the committee recommends, "should be used in all cases of coronary thrombosis with myocardial infarction" unless there is a definite reason against it. A tendency to bleeding or hemorrhage would be one such reason.

Coronary thrombosis is the kind of heart disease in which one of the arteries of the heart muscle is plugged, usually by a blood clot. Myocardial infarction is the damage to the part of the heart muscle that is not getting enough blood because of the artery stoppage.

The death rate and the number of complications in the way of repeated attacks of thrombosis during the first six weeks after an attack are "markedly lower" in patients treated with the anti-clotting chemicals than in patients treated by conventional means without these chemicals, the committee found.

The 800 patients in the study were under the care of 18 collaborating physicians in 16 different hospitals throughout the country. About half of them, those entering the hospital on the odd days of the month, received the anti-clotting chemicals. The others, entering on even days of the month, were given conventional treatment only. Age, sex and heart condition of patients in each group was about the same.

The chemicals act to relieve the heart condition by slowing the rate at which the blood clots. In using them, tests should be made daily to determine the clotting time of the blood. This precaution guards against giving too much of the chemicals, which might cause hemorrhage, and also is important for guiding the physicians to give enough to help the patient.

The greatest saving of lives occurred in patients over 60 years, the committee found. But the treatment is valuable for younger patients in reducing the number of further attacks, each of which may cause disability or death.

Beginning the treatment even as late as the second or third week after an attack brings benefits.

Chemical Improves Syphilis Test

➤ BLOOD TESTS for syphilis are becoming more reliable, thanks to a new testing chemical discovered by Dr. Mary C. Pangborn of the New York State Department of Health.

When a blood test for syphilis is done on a patient with malaria or a vaccinated person, the report often is positive even when the person does not have syphilis. Such tests are called "false positives." They have long been a source of worry to doctors and patients.

Many of these false positive tests will be eliminated when the new testing chemical is used, it appears from results with it so far.

The chemical is named cardiolipin. It is a phosphorus containing fatty substance obtained from beef heart. For many years extracts from beef heart have been used in blood tests for syphilis, but since these were crude extracts it was almost impossible to get two of them exactly alike. Consequently it was difficult to standardize the test material so that the test would be the same when performed in different laboratories. Efforts to purify the beef heart extracts led to discovery of the new compound, cardiolipin.

Besides its advantages of specificity and ease of standardization, the new chemical has the further advantage of being adaptable to different test procedures.

Biology-Medicine Research for AEC

➤ A COAST-TO-COAST program of 38 research projects in medicine and biology is to be conducted in 29 nongovernment laboratories by the U. S. Atomic Energy Commission. The Commission has made available $1,300,000 for the projects.

The subjects for the studies range from genetics of fruit flies and corn and the nutrition of tapeworms to cancer research and airborne infectious diseases.

Radiation-induced gene and chromosomal mutations in drosophila (fruit flies) and corn will be investigated at the California Institute of Technology, Pasadena. Research on the nutrition of tapeworms will be conducted at Rice Institute, Houston, Tex. The Memorial Hospital for Treatment of Cancer, New York, will study cancer and the distribution of isotopes in therapy. Work on airborne infectious diseases will be done at the University of California, Berkeley.

Enriching Mother's Milk With Vitamin A Promises Saving Lives of Babies

Advances in Vitamin Chemistry

➤ BREAST-FED babies can be insured against vitamin A starvation if their mothers take the growth-essential vitamin in a newly developed water solution instead of in the usual oily form.

With breast-feeding on the increase again, as pediatricians and psychiatrists recognize its superiority over other types of feeding, the problem of enriching the milk with vitamin A assumes new importance, according to a paper by Dr. Albert E. Sobel, Dr. Abraham Rosenberg, and Dr. Benjamin Kramer of The Jewish Hospital of Brooklyn before the meeting of the American Chemical Society.

Asserting that case histories show "several instances of death due to vitamin A deficiencies of children fed on breast milk," the paper said use of the new water-soluble form enables babies to obtain up to 800 per cent more of the vitamin than they can get from oil solutions.

The water-soluble vitamin A is picked up more efficiently by the mother's blood than is vitamin A in oil.

An adequate supply of vitamin A is necessary for adults as well as children for the maintenance of proper health. A deficiency results in such symptoms as night blindness, degeneration of the skin, nerves, lung lining, and tooth structure, and the formation of kidney stones.

"The fact that vitamin A is taken in adequate amounts is no guaranty that sufficient quantities of it will pass through the intestine into the blood, which then transports it to various parts of the body," the report explained, adding that earlier studies showed vitamin A was scarcely absorbed at all by infants from the oily solution usually employed, but is efficiently taken up by the blood from a water solution.

In another paper, Dr. Sobel and Dr. Rosenberg described a new method for the estimation of the vitamin A content in milk which, though accurate, is extremely simple and requires very small amounts of milk. The method, it was said, has made it possible to study the vitamin A content of human milk at frequent intervals after feeding various vitamin A preparations without depriving the infant of this nutrient.

The new technique is based on colorimetric reaction between vitamin A and a chemical called glycerol dichlorohydrin, or GDH for short. The color which is produced is stable and is not affected by moisture or high humidity, according to the paper, which said that heretofore the only available way to analyze vitamin A in milk depended upon a color formed with antimony trichloride, which was so fleeting that the measurement had to be made within four seconds.

Moreover, traces of moisture or humid weather interfered with the proper development of this color, and

the antimony trichloride was so corrosive that if a drop of it fell on the expensive color-measuring instrument, it would cause serious damage.

In addition to the introduction of the new reaction, the paper said, the method of extracting vitamin A from the milk sample has been so greatly simplified that 50 to 100 determinations a day can be carried out easily in a small space. Under the old system, only a half dozen analyses could be made, and they required continuous hard labor and relatively large amounts of inflammable chemicals.

Further evidence that water-soluble vitamin A is taken up more efficiently by the blood than is vitamin A in oil was submitted in a paper by Charles J. Kern and Thomas Antoshkiw of the research and development laboratories of the International Vitamin Division, Ives-Cameron Company, Inc., Brooklyn. Experiments showed that vitamin A dissolved in water is far more stable than vitamin A in oil, and thus is less likely to be destroyed by the oxygen in the air at ordinary room temperature.

Noting that the shortage of vitamin A is world wide, the paper said that the greater stability and better absorption of water-soluble vitamin A is of real significance in relieving the shortage and protecting the public using vitamin A.

Vitamins in Water Solution

➤ INTRAMUSCULAR injections of recently developed water solutions can now be administered for vitamin deficiency.

The new aqueous solutions, developed as a result of several years' research, contain vitamins soluble both in oils or fats and in water, according to Dr. Louis Freedman, vice-president and direcor of research of the U. S. Vitamin Corporation, New York, speaking to the American Chemical Society.

This new development gives the medical profession a new mode of administering vitamins not absorbed easily by way of the alimentary system.

Many persons lacking necessary vitamins have been unable to derive full benefit from prepared vitamins when taken orally in capsules, pills or oil, because of the failure of their systems to absorb the vitamins properly, Dr. Freedman said.

Fat-soluble vitamins such as A for growth, D for bone nourishment and E, the anti-sterility factor, are utilized by the body from five to twenty times more rapidly from the aqueous mixtures than from oily vehicles.

Lower Cost Vitamin D

➤ A NEW synthetic process promises to increase the supply and lower the cost of bone-nourishing vitamin D.

Studies of vitamin D-3, one of the two most common forms of vitamin D, have resulted in a greatly increased output assuring the feasibility of producing it commercially on a large scale and hence lowering its costs, according to a paper presented before the American Chemical Society's organic division by five chemists of the Lederle Laboratories Division of the American Cyanamid Company, Pearl River, N. Y.

This development should also tend to lower the cost of poultry feed, the vitamin content of which consists

largely of vitamin D-3. Chickens receive only small benefit from vitamin D-2, the other widely employed vitamin D form, which heretofore has been cheaper to make than vitamin D-3. The human body, the paper said, can use either D-2 or D-3, although D-3 is considered the human vitamin D. The cost of D-3 has prevented its widespread use.

All vitamin D derivatives are made by ultraviolet irradiation of a precursor substance known as provitamin D. Vitamin D-3 comes from provitamin D-3, or 7-dehydrocholesterol, and D-2 from provitamin D-2, or ergosterol. Ergosterol is easily isolated from yeast, whereas isolation of provitamin D-3 is not commercially practical.

Hence research has concentrated on synthesis of provitamin D-3. Synthesis was first achieved in 1935, when it was prepared from cholesterol, a common natural substance, but the process left much to be desired.

A new method of provitamin D-3 synthesis was found in 1942 by Germans, who did not elaborate on their results, and this started scientists in many countries working on the problem.

Recent studies have shown that one of the more convenient ways of preparing provitamin D-3 is to begin with cholesteryl benzoate and add bromide in a light petroleum solvent under strong illumination. The low boiling solvent is removed by vacuum distillation and a resulting oily residue is then dissolved. Various chemicals are added, and 7-dehydrocholesteryl benzoate is formed. Finally provitamin D-3 is produced by hydrolysis.

Chemists conducting the studies were Seymour Bernstein, Louis J. Binovi, Louis Dorfman, Karl J. Sax and the late Dr. Y. Subbarow of the Lederle Laboratories Division of the American Cyanamid Company, Pearl River, N. Y.

Soluble Form of Riboflavin

➤ A HIGHLY soluble form of vitamin B-2, or riboflavin, will enable physicians to administer much larger doses in the treatment of deficiency cases.

This advance in vitamin therapy, the work of researchers in the laboratories of Endo Products, Inc., New York was reported to the American Chemical Society in a paper by Karl Schoen and Samuel M. Gordon. Two teaspoonfuls of a solution containing the new product provide as much of the vitamin as 100 quarts of milk, one of the richest natural sources.

Riboflavin, a dietary essential which is one of the nutrients used to fortify white bread, combines with phosphoric acid and a protein in the body to form a yellow enzyme, or chemical accelerator, which is present in every cell and plays an important part in respiration and the utilization of sugars and proteins.

Signs of a mild deficiency, which may pass unnoticed, include a lower health level, retarded growth, and a tendency to irritation of the skin, according to the report, which said more advanced deficiencies are evidenced by soreness of the lips and tongue, cracking of the skin at the corners of the mouth, and inflammation of the eye.

Riboflavin was first identified in milk in 1879, and was then called lactochrome, but its physiological im-

portance was not recognized. In 1932, the pure form of an enzyme isolated from yeast was found to play an important role in the respiration of that organism. Because of its intense yellow color, this substance was called "yellow respiratory enzyme." Subsequent investigation revealed a similar coloring material in eggs, milk, and animal tissues. The widespread distribution of this pigment led to the identification of the substance as riboflavin, a member of the vitamin B complex, and eventually resulted in its synthesis.

Although synthetic riboflavin is now available in large quantities, its poor solubility has necessitated undesirable and inconvenient procedures for preparing solutions, the paper stated. Because the vitamin must be injected in some cases, as in digestive disturbances, many efforts have been made to increase its solubility in order to prepare more concentrated solutions.

When large amounts of this vitamin are to be given by injection, the new highly soluble riboflavin overcomes the common drawbacks of the preparations available heretofore, the paper reported. Favorable results with these new riboflavin derivatives have been reported in clinical trials now under way.

"The outstanding feature of the new riboflavin compounds is high solubility in water. These compounds are 100 to 1,000 times as soluble as riboflavin itself, so that five times the average daily requirements can be easily dissolved in one cubic centimeter of water.

Vitamin A Research

➤ A TEN-YEAR-OLD scientific controversy over the nutritional value of vitamin A-2, a substance found in the livers of certain fresh water fish, has apparently been settled.

Vitamin A-2 has the same effects but is only about half as potent as vitamin A, the closely related nutrient obtained from the livers of salt water fish such as the cod and shark, according to an American Chemical Society paper by Edgar M. Shantz and John Brinkman of the research laboratories of Distillation Products, Inc., Rochester, N. Y.

Ever since the discovery of vitamin A-2, investigators throughout the world had disagreed about its biological activity. Some said it behaved like vitamin A, others said it didn't. Still others asserted that it was changed into the regular vitamin A when fed to mammals.

The only way to end the dispute was to isolate some pure vitamin A-2, the paper pointed out. So the Rochester chemists collected 150 pounds of pike livers from fish markets and treated them by a long, involved series of extractions and purification steps.

Finally, about one-hundredth of an ounce of orange crystals was obtained, and this was shown to be a pure derivative of vitamin A-2.

When this preparation was fed to vitamin A-deficient rats, the animals needed about twice as much vitamin A-2 as vitamin A to grow well and keep healthy. Thus, instead of being inactive, vitamin A-2 has nearly half as much growth-promoting power as regular vitamin A. Furthermore, by

examining the livers of these animals it was found that they used the vitamin A-2 as such, without changing it into vitamin A.

Another research from the same laboratory was on "Anhydrovitamin A," a substance obtained when vitamin A is treated with an acid to remove its water content. Rats raised on a diet of anhydrovitamin A instead of vitamin A required 300 times as much to grow normally.

In utilizing this vitamin, they changed some of it into a new and hitherto unrecognized compound and stored some of the new compound in their livers. Mr. Shantz extracted about one ten-thousandth of an ounce of this new compound from the livers of 150 rats. When this substance was fed to vitamin A-deficient rats, it was found that they required only fifteen times as much of the compound as of vitamin A to remain alive.

These studies also cleared up another mystery: that of the "beta ionone ring," a grouping of carbon atoms formerly found in all natural compounds having vitamin A activity and thus thought to be essential. Neither vitamin A-2 nor the new compound formed from anhydrovitamin A has such a ring, Mr. Shantz reported. He concluded that although the ring is not necessary, "any compound lacking it will probably not be as active as vitamin A itself."

In the chemical production of anhydrovitamin A, water is split out of the vitamin A molecule. An extra "double bond" is formed and the five original double bonds of vitamin A are shifted to new positions in the molecule. Although only a minute amount of the new substance formed in the livers of the rats was available for study, Mr. Shantz was able to determine that the rats, apparently in an effort to change anhydrovitamin A back into vitamin A, had succeeded in getting water back into the molecule. Thus, the extra double bond was eliminated, but the five remaining double bonds had not been shifted back to their original positions.

Unbalanced Equations

➤ SCHENECTADY, N. Y.,—An absent-minded printer spoke for millions of atom-bewildered citizens while setting type for a general Electric Company handbook on nuclear physics. A handbook sheet which describes the giant atom-smashers G.E. makes and sells carries a boldface headline declaring, "UNCLEAR PHYSICS."

Properties of Monolayers Make Interesting Experiments

Thin Films on Water

Reprint of a lecture delivered before the Royal Institution of Great Britain.

by E. K. RIDEAL

Fullerian Professor of Chemistry; Director of the Davy Faraday Research Laboratory.

➤SIR JAMES DEWAR devoted several of his Friday Evening Discourses to investigations on soap bubbles. He was chiefly concerned with such problems as the permeability and viability of these films. There are many other interesting aspects which are worthy of study and this evening I propose to deal with one of them, namely, their structure.

Oil drops spread on wet asphalt and soap bubbles exhibit brilliant colours. These, as we know, are the so-called Newtonian interference colours. Their presence indicates that we are dealing with thin films, and what is important is that these thin films are of uniform thickness, although multimolecular, and extend over relatively large areas. In addition, we note one film can apparently slide over another with comparative ease, as is readily demonstrated by observing the colour changes when a stream of air impinges on the surface of a soap bubble.

We can examine how these films are formed by investigating the behaviour of drops of organic materials when placed on a water surface. A drop of nujol or thick paraffin oil remains as a sessile drop on the water surface, but a drop of oleic or other fatty acid moves about and, as revealed by lightly dusting the surface of the water with powdered talc, some acid spreads from the drop. The chemical difference between these two substances resides in the fact that the oleic acid has a polar or water solubilizing group, the carboxyl group attached to the hydrocarbon and water insoluble chain. We thus suspect that the molecules in the surface of the oleic acid drop which present their polar groups to the water, can dissolve in it and the whole molecule is torn away from the drop. Since there is a long chain attached to the polar group, the molecule does not dissolve in the water but floats on the surface, with the polar group in the water and the chain in the air. As more molecules float off into the surface it becomes eventually so crowded that no more are detached, or rather, that the rate of surface solution is just balanced by the rate of return of detached molecules. It is clear that we obtain a sheet of orientated molecules, one molecular layer thick in equilibrium with the lens. If we attempt to compress this monolayer by means of a slide or a waxed cotton thread or paper barrier, then molecules will return into the lens. It is for this reason that lenses in equilibrium with their monolayers have been termed "piston oils." For whatever the area exposed the pressure of the monolayer on the confining barriers remains the same. It is a

simple matter to measure the spreading coefficients and the piston oil pressures of various organic compounds and find out how they depend on the polar and non-polar portions of the molecules respectively. For example, the spreading coefficients at 20°C. of nitrobenzene, ethyl bromide and oleic acid are 3.8, 17.9 and 24.16 dynes per cm. respectively. . . .

Similar spreading phenomena can be observed on substrates other than water; thus camphor and various perfumes will spread on mercury.

We may note that if we push the monolayer back rapidly, the molecules on the surface may not have time to re-enter the sessile drop and as a consequence the film may buckle and break up into small crystallites or lenses. Some molecules if on water as substrate may be forced into solution, whilst if on mercury, may be forced into the air. This latter phenomenon of forced evaporation is an interesting one. For example, if a small quantity of solution of camphor be spread upon mercury and the solvent be allowed to evaporate, the remaining monolayer is relatively stable; in fact, it evaporates at a rate which is only 1/700 of that from the solid camphor, but on compression the odour of camphor is clearly discernible. The camphor may likewise be replaced by water.

It has been suggested that hounds follow scent best after a shower of rain on dry ground, due to this displacement. The slowness of the rate of evaporation of scents from a pocket handkerchief is remarkable and in striking contrast to the apparent volatility of the scent in liquid form.

The perfume emitted by the flowers of plants may be detected in a similar manner. When a rose petal or lilac flower is suspended a few millimeters above the surface of talc-dusted mercury, it will be noted that the talc particles are set in motion and pushed out in an ever-widening circle. On removal of the source of scent the circle will commence to close, although frequently closure is incomplete owing to the formation of complex non-volatile oxidation products.

Instead of forming the monolayers on water by surface solution from a lens or crystal, they may also be formed by dissolving an appropriate quantity of the material in a volatile solvent such as petrol ether and allowing a measured quantity of the solution to spread on the water. After evaporation of the water the material is left in the form of a monolayer. That they are true monolayers was first confirmed by Dr. Langmuir who showed that in a series of fatty acids of different chain lengths a given number of molecules would always occupy the same area on compression. Since the chains vary in length we must conclude that at this compression they are vertically orientated to the water surface.

There are several methods by which the properties of these monolayers can be examined, and I hope to make this the subject of a future discourse. Here I would merely observe that the floating molecules are constituted of two portions, the hydrocarbon chain or tail and the polar or soluble head. The relationship between the area occupied by the molecules and the compressional force gives us information about the hydrocarbon tails and this can be evaluated most readily by means of the Langmuir balance; whilst the be-

haviour and reactivity of the heads can be examined by means of the determination of the phase boundary potential by the methods of Rideal and Schulman. . . .

We have noted that these surface films possess surface viscosities. In addition, many of the films under consideration possess marked rigidities and some are highly elastic. For example, surface films of proteins in the condensed state are remarkably elastic and it is indeed possible to determine a definite elastic modulus. The elasticity of an albumen monolayer can readily be demonstrated by observing the movement of a barrier in the film after being subjected to a small displacement by application and removal of a small force.

The elastic and coherent qualities of such surface films play important roles in the operation of ore flotation. Thus substances like terpineol are used to form coherent films. In the separation, for example, of zinc sulphide from calcium carbonate, if we add a minute amount of potassium ethyl xanthate, the sulphur group in the xanthate anchors the hydrophobic ethyl group to the zinc ions in the surface of the zinc sulphide which thus becomes water repellant. Even more effective is the prior addition of a trace of copper sulphate which replaces some of the zinc ions by the more reactive copper ones. These hydrophobic particles are caught up in air bubbles which have terpineol layers as their protective membrane. If we replace the xanthate by a trace of sodium sulphide and sodium oleate, the calcite is rendered hydrophobic, rather than the zinc, and its flotation can be effected.

If such a condensed monolayer be confined at constant pressure by means of a piston oil, it was first shown by Dr. Langmuir and Miss Blodgett that it could be transferred to a glass or metal surface by the simple process of dipping the glass or metal into the water and through the film.

Further investigation has shown that there are three different types of deposition. X deposition when it occurs only on the downward movement of the slide through the monolayer. Y on both downward and upward movements, and Z on the upward movement only. The contact angle of the water with the film for X deposition must be greater than 94°, and for Z deposition less than 80°. By repeated dipping, a series of monolayers can be built up on the top of one another, and we have found that the deposition can be effected on artificially grooved surfaces and wire gauze. The multilayers so formed are stretched over the undulations just like a soap film.

The optical thickness of these multilayers can be determined from the interference colours. We have, in fact, built up a coloured film in properties akin to a soap bubble. . . .

These multilayers on chromium plates reduce the coefficient of friction very considerably when weights are slid over the surface, and notable effects are observed when only a few layers are deposited.

There are many other interesting properties of the multilayers, but tonight I have confined myself to those properties which help us to elucidate the structure of the laminated form of soap films from observations on the properties of thin films on water.

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